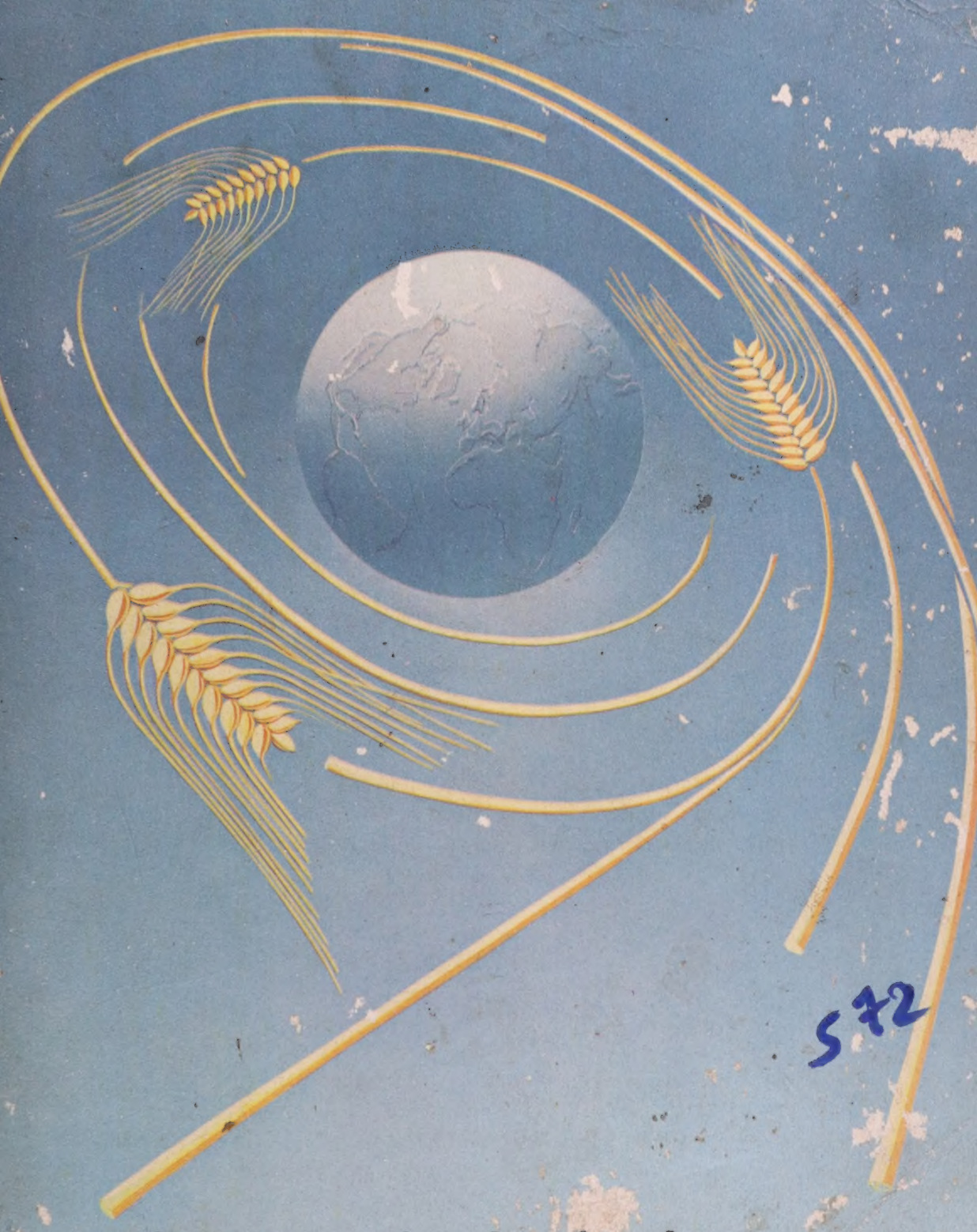

fisheries in the food economy

Basic Study No. 19

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

FREEDOM FROM HUNGER CAMPAIGN

Basic Studies Series

Between 1961 and 1963, 15 volumes in the Basic Studies series were published by the Food and Agriculture Organization of the United Nations (FAO) and other agencies of the United Nations in support of the Freedom from Hunger Campaign.

During 1967 and 1968, a further 9 volumes of Basic Studies will be issued in continuation of the series. Like those previously published, they have been specially written to assist individuals and groups in studying the critical problem of hunger and its related social, economic and technical issues. They provide valuable background material, not easily obtainable elsewhere in concise form, for discussion among nonspecialists.

The titles previously issued are as follows:

1. *Weather and food*, WMO, Geneva.
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3. *Animal disease and human health*, FAO, Rome.
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6. *Education and training in nutrition*, FAO, Rome.
7. *Population and food supplies*, United Nations, New York.
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9. *Increasing food production through education, research and extension*, FAO, Rome.
10. *Possibilities of increasing world food production*, FAO, Rome.
11. *Third world food survey*, FAO, Rome.
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FISHERIES IN THE FOOD ECONOMY

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FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS ROME 1968

Printed in Italy

FOREWORD

Five years ago, in June 1963, FAO celebrated the twentieth anniversary of the Hot Springs Conference by holding the World Food Congress at Washington. It was a historic assembly of leading personalities drawn from all parts of the world — statesmen, scientists, administrators, sociologists and philanthropists — who shared our growing concern about the expanding dimensions of hunger and malnutrition so dramatically brought out by FAO's Third world food survey. *The late President Kennedy, in his inaugural address, made a stirring plea for the abolition of hunger and malnutrition, and set the tone and entire purpose of the Congress in the following words*:

> *" So long as freedom from hunger is only half achieved, so long as two thirds of the nations have food deficits, no citizen, no nation, can afford to be satisfied. We have the ability, as members of the human race. We have the means, we have the capacity to eliminate hunger from the face of the earth in our lifetime. We need only the will."*

The Declaration issued by the participants at the end of the Congress highlighted the moral and social aspects of the challenge of hunger and urged the need for massive action to mobilize the national and human resources of all mankind to meet it effectively. It suggested future lines of work and priorities for action, at both national and international levels. At the national level, the highest priority was given to the need for increasing agricultural productivity and population stabilization in the developing countries. At the international level, the developed countries were urged to adopt more rational and far-sighted policies in regard to aid and trade in agricultural exports. Particular emphasis was placed

on the role of science and technology in achieving economic and social progress in the developing countries.

In the years following the United Nations set up a Conference on Trade and Development (UNCTAD) and organized a conference on the transfer of science and technology for the benefit of developing countries with a permanent panel of scientists to advise national governments and international agencies. A World Population Conference was held in 1965 under United Nations auspices. These are significant developments.

The Congress participants had no illusion that such a vast and deep-rooted problem as hunger and misery affecting two thirds of mankind could be brought under control in a matter of years. They therefore recommended that a World Food Congress should be held " periodically to review a world survey, presented by the Director-General of FAO, of the world food situation in relation to population and overall development, together with a program for future action." It was in accordance with this resolution that the Director-General was authorized by the FAO Conference to prepare an Indicative World Plan for Agricultural Development to be presented to the second World Food Congress scheduled to be held in 1969. Indeed, the Indicative World Plan and its findings would be the major theme of the forthcoming Congress.

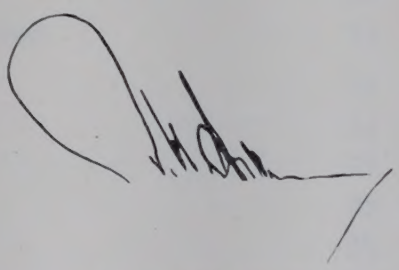
It is becoming increasingly clear that supreme efforts will be needed, both at the national and global levels, to avert famines and serious shortages in the coming decades. Not only has food production in the developing countries not kept pace with their rising populations, but in some regions per caput food production has shown a decline. The prospects for any marked improvement in agricultural prices on world markets are far from bright. Flow of overseas investment capital to the developing countries has become stagnant if indeed it has not declined during the last few years. The Indicative World Plan will attempt to present a coherent picture of the current and future needs and the possibilities of meeting them.

Meanwhile, as in the case of the first World Food Congress, a number of Basic Studies are being issued by FAO and other co-operating international organizations to aid citizens to ponder and discuss the crucial socioeconomic problems affecting peace and stability in our shrinking world.

The present study focuses on the contribution of sea and inland water food resources to the improvement of dietary and income levels in developing countries. In many of these countries, fish and shellfish play an important

part in nutrition. In addition, a growing number of developing countries are deriving significant foreign exchange earnings from the export of fishery products to developed countries. With rising pressure on food-producing land resources, an increasing share of future food supply needs, especially of developing areas, may have to be met from fisheries. Today, the majority of developing countries lack the finances and skills for large-scale fisheries expansion. At the same time, low purchasing power holds back translation of potential into effective demand. Vast efforts, therefore, will be necessary (including assistance from bilateral and international sources) to create the means and incentives for increased production and consumption of fish and fishery products in developing countries.

The next two or three decades will be a critical period in our history, when the primary needs of vastly increased populations for food, housing, education, etc., will have to be met. Through the Freedom from Hunger Campaign, FAO has attracted the dedication and moral commitment of countless people all over the world in the attainment of its cherished objectives. I hope the second World Food Congress will take our struggle for the alleviation of hunger and misery a big and decisive step forward and help to further crystallize that collective will which alone can ensure victory.



A. H. BOERMA
DIRECTOR-GENERAL

CONTENTS

industries, modern fish harbor and fishing boat construction facilities, and other installations serving the industry, the share of catch value in total national product does not adequately reflect the importance of fisheries in the national economy.

Because of the geographic concentration of fisheries activities in coastal areas and in the vicinity of major inland water bodies, regional data are frequently a better gauge than national averages of the role of fisheries in the economy and in employment. Thus, large segments of the population in the coastal areas of Japan and other countries of Southeast Asia, of Newfoundland and Scandinavia, as well as the communities located on the shores of the lakes and rivers of Africa, depend for their livelihood almost exclusively on fisheries.

International trade in fishery products, valued at close to $2,000 million, accounts for about 1 percent of total world trade and is equivalent to about one fifteenth of the total trade in agricultural primary commodities. In 1965, about one fourth, by value, of the total exports of fishery products originated in developing countries.

In a small number of countries, fishery exports make up a rather high proportion of total export earnings. Valued at over $186 million, Peru's exports of fishery products in 1965, mostly fish meal and fish oil, accounted for about 25 percent of the total value of the country's commodity exports. Other developing countries whose fishery exports have in recent years exceeded $10 million in value are Mexico, Morocco, the Republic of Korea, Chile, Pakistan, India and Malaysia. The leading exporters of fishery products among developed countries are Japan, Norway and Canada.

Over 70 percent, by value, of the world export trade in fishery products is destined for markets in six major developed countries; namely, the United States, the United Kingdom, the Federal Republic of Germany, France, Italy and Japan. In 1965, these countries absorbed close to three fourths of the fishery export trade of developing countries.

In catch term equivalent, slightly less than 70 percent of all the fish and shellfish produced in 1965 was utilized for food purposes. Most of the remainder was processed into meal and oil used in pig and poultry rations and in the manufacture of margarine and other food products, and thus made an indirect contribution to food supplies.

Fisheries contribute about 1 percent of the total food supply of the world. The part played by fish in the diet varies greatly from

country to country. In some countries virtually no fish is consumed. Elsewhere, notably in a few developed countries with important fishery industries and a population with traditional food preferences for fish, and in developing countries in the Far East and in Africa with low calorie diets, only cereals, starches and fruits are consumed in larger quantities than fish.

Table 1 shows annual per caput fish consumption for the three years centered on 1961, by country, and separately for developed, centrally planned and developing regions. The table also includes details on nutritional aspects.

According to the table, per caput consumption in developed countries ranges from less than 7.5 kilograms in Austria and Ireland to as much as 61.3 kilograms in Norway. Consumption rates are high also in the other Scandinavian countries as well as in Japan and in the Iberian peninsula. In contrast, per caput fish intake in the United States and Canada, both leading fish producers, is relatively low.

Of the centrally planned countries, Eastern Germany and the U.S.S.R., with 12.6 and 11.4 kilograms respectively, have the highest per caput fish consumption. The Balkan countries have the lowest consumption rates in Europe.

Characteristic features of fish consumption patterns in developing regions are the relatively high level of intake in the Far East and the generally very low level in the Near East. In other regions, fish is popular especially in West Africa and in the Caribbean area as well as in a few South American countries. In landlocked countries without major water bodies, such as the Central African Republic and Afghanistan, little fish is consumed.

In terms of nutritional value, fish contributes to the daily diets of the population of the countries listed in Table 1, as follows:

Calories: from less than 1 gram to 75 grams
Fat: from less than $^1/_{10}$ gram to 4 grams
Proteins: from less than $^1/_{10}$ gram to 13 grams

From a nutritional standpoint, the animal protein contribution of fish to the diet is especially important. In most countries of the Far East, in many developing countries of Africa south of the Sahara, and in Japan and Portugal, about one half -- and in some instances

TABLE 1. – THE PLACE OF FISH IN FOOD CONSUMPTION
(Per caput consumption - base period 1960-62)

Country	Quantity	Calories per day	Protein	Fat	Percentage of total food consumption provided by fish				Fish as percentage of monetary value of food at primary producer's level
	Kg per year		Grams per day		Calories	Fat	Protein	Animal protein	
(1) *Developed countries*									
Australia	10.0	18	2.6	0.7	0.6	0.5	2.9	4.4	2.97
Austria	7.5	15	2.0	0.7	0.5	0.6	2.3	4.2	2.78
Belgium-Luxembourg	12.5	22	2.6	1.1	0.7	0.8	3.0	5.7	4.63
Canada	9.8	23	3.3	1.0	0.8	0.7	3.6	5.5	2.30
Denmark	33.0	60	8.3	2.6	1.8	1.7	8.9	14.3	10.60
Finland	21.1	42	5.7	1.8	1.3	1.6	6.1	10.4	8.00
France	10.5	30	4.3	1.5	1.0	1.3	4.2	7.2	3.42
Germany, Fed. Rep. of	13.4	24	3.5	1.1	0.8	0.9	4.4	7.1	4.92
Greece	19.0	34	5.2	1.3	1.2	1.5	5.5	17.0	8.33
Ireland	7.4	17	2.1	0.8	0.5	0.6	2.3	3.9	2.41
Israel	15.0	19	3.0	0.6	0.7	0.7	3.6	8.3	6.34
Italy	10.4	24	3.2	1.1	0.9	1.4	4.0	10.7	4.74
Japan	49.4	62	9.3	1.9	2.8	5.2	13.5	55.0	3.06
Netherlands	11.1	20	2.5	1.0	0.7	0.8	3.2	5.5	4.42
New Zealand	12.2	21	3.3	0.7	0.6	0.4	3.0	4.4	3.48
Norway	61.3	69	9.7	3.0	2.4	2.3	11.9	19.9	21.78
Portugal	48.4	75	12.9	2.6	2.9	3.9	17.8	47.4	23.83
South Africa	19.7	55	6.0	3.3	2.0	4.9	7.5	19.0	9.65
Spain	26.4	43	6.1	1.8	1.5	2.0	7.9	26.1	12.80
Sweden	26.7	70	7.3	4.1	2.3	3.0	8.8	13.4	9.83
Switzerland	8.7	20	2.1	0.9	0.6	0.7	2.3	4.1	2.85
United Kingdom	18.8	28	4.2	1.1	0.8	0.8	4.7	7.9	6.03
United States	8.7	21	2.5	1.0	0.7	0.7	2.7	3.9	2.03
(2) *Centrally planned countries*									
Bulgaria	1.5	3	0.4	0.1	0.1	0.2	0.5	2.5	0.83
China (Mainland)	5.9	7	1.4	0.2	0.3	0.7	2.3	20.9	5.24
Czechoslovakia	4.5	8	1.1	0.3	0.3	0.3	1.6	3.4	2.02
Eastern Germany	12.6	21	3.0	0.9	0.7	0.7	4.6	9.3	5.04
Hungary	1.6	3	0.4	0.1	0.1	0.1	0.6	1.3	8.80
Poland	6.6	11	1.6	0.5	0.4	0.5	2.1	4.7	3.11
Romania	1.8	3	0.4	0.1	0.1	0.2	0.5	1.9	1.06
U.S.S.R.	11.4	19	2.7	0.8	0.6	1.2	3.1	9.3	5.73
(3) *Developing countries*									
LATIN AMERICA									
Argentina	4.3	8	1.1	0.3	0.3	0.3	1.3	2.1	1.69
Bolivia	0.5	1	0.1	—	0.1	—	0.2	0.9	0.52
Brazil	5.3	13	1.9	0.5	0.5	0.8	2.9	10.6	3.21
British Honduras	9.6	16	2.3	0.7	0.8	1.3	0.6	16.4	8.30
Chile	12.5	30	3.4	1.7	1.2	3.3	4.4	12.5	6.98
Colombia	2.4	9	1.3	1.0	0.4	1.0	2.7	5.9	2.23
Costa Rica	2.6	5	0.7	0.3	0.2	0.6	1.3	3.4	1.69
Cuba	5.3	10	1.3	0.4	0.4	0.5	2.1	4.8	2.71
Dominican Republic	6.0	10	1.4	0.4	0.5	0.8	3.4	11.8	4.02
Ecuador	9.0	16	2.2	0.6	0.8	1.7	4.5	12.9	6.68
El Salvador	2.3	4	0.6	0.2	0.2	0.5	1.1	4.0	2.30
Guatemala	0.3	1	0.1	0.1	0	0.3	0.2	1.1	0.32
Haiti	4.6	8	1.1	0.4	0.4	1.2	2.4	16.2	3.56
Honduras	1.4	2	0.3	—	0.1	—	0.6	2.4	1.24
Jamaica	21.0	36	5.1	1.6	1.6	3.0	8.8	26.4	10.35
Mexico	4.9	7	1.3	0.2	0.3	0.3	1.8	5.9	3.53
Nicaragua	1.4	3	0.4	0.2	0.1	0.4	0.6	1.4	0.90
Panama	10.8	22	3.4	0.7	1.0	1.3	6.3	17.2	6.81
Paraguay	0.6	1	0.1	—	0	—	0.2	0.4	0.35
Peru	13.5	30	3.5	1.6	1.4	4.6	6.1	19.4	8.84

THE PLACE OF FISH IN FOOD CONSUMPTION *(concluded)*

(Per caput consumption – base period 1960-62)

Country	Quantity	Calories per day	Protein	Fat	Percentage of total food consumption provided by fish				Fish as percentage of monetary value of food at primary producer's level
	Kg per year		Grams per day		Calories	Fat	Protein	Animal protein	
(3) Developing countries (continued)									
Surinam	20.7	49	6.3	2.2	2.5	4.9	14.2	41.7	15.87
Trinidad and Tobago	14.1	24	3.4	1.0	1.0	1.6	5.4	17.3	8.68
Uruguay	3.1	5	0.8	0.2	0.2	0.2	0.8	1.3	1.23
Venezuela	13.8	35	3.9	1.2	1.5	2.0	6.7	16.7	8.55
NEAR EAST									
Afghanistan	—	—	—	—	—	—	—	—	—
Iran	1.5	2	0.4	0.1	0.1	0.3	0.7	3.0	1.68
Iraq	1.6	3	0.4	0.1	0.1	0.3	0.6	2.3	1.48
Jordan	1.8	4	0.7	0.1	0.2	0.2	1.1	6.5	1.54
Lebanon	3.7	11	1.0	0.7	0.5	1.1	1.5	5.2	2.42
Saudi Arabia	1.3	2	0.3	0.1	0.1	0.4	0.7	2.5	1.37
Sudan	1.4	2	0.3	0.1	0.1	0.2	0.4	1.3	1.35
Syria	0.1	—	—	—	—	—	—	—	0.08
United Arab Republic	5.2	10	1.2	0.3	0.4	0.8	1.7	11.9	5.21
AFRICA									
Algeria	2.0	10	1.1	0.5	0.4	1.3	1.7	9.0	1.26
Angola	19.8	33	4.6	1.6	1.5	3.7	7.7	38.7	11.58
Cameroon	13.2	22	3.2	1.0	1.0	2.1	6.3	40.5	10 00
Central African Republic	0.4	1	0.1	—	0	—	0.3	1.6	0 34
Congo-Rwanda-Burundi	9.8	17	2.4	0.7	0.8	2.0	5.9	57.1	7.78
Ethiopia	0.5	1	0.1	—	0	—	0.1	0 5	0.39
Kenya	2.4	4	0.6	0.2	0.6	3.6	3.7	22.5	1.82
Libya	1.8	5	0.6	0.3	0.3	0.8	1.0	4.8	1.16
Madagascar	7.5	13	1.8	0.6	0.6	3.6	3.7	22.5	5.27
Mauritius	12.7	30	4.0	1.3	1.3	2.6	8.5	32 5	8 70
Morocco	6.2	30	3.4	1.7	1.4	3.9	5.1	21.8	4 23
Mozambique	3.7	6	0.9	0.3	0.3	1.0	1.8	19.6	3 59
Nigeria	5.8	9	1.4	0.4	0.4	1.0	2.3	21.5	5.20
Rhodesia-Malawi	4.5	8	1.1	—	0.3	—	1.8	10.6	4.05
Somalia	—	—	—	—	—	—	—	—	—
Tanganyika	6.2	10	1.5	0.5	0.5	1.7	2.6	20 5	5.51
Tunisia	2.6	13	1.4	0.7	0.7	1.6	2.7	14.3	1.86
Uganda	8.8	21	2.4	1.2	0.9	3.1	4.4	13.1	6.32
West Africa									
Savanna zone	10.2	19	3.4	0.3	0.9	0.8	4.9	27.2	8.63
South zone	12.7	33	4.1	1.6	1.6	6.5	8 9	56.9	10.81
Southwest zone	12.0	28	4.2	1.2	1.3	3.4	10.0	67.7	9.74
ASIA AND FAR EAST									
Burma	18.3	31	4.4	1.4	1.4	4.2	9.5	50.0	13.48
Ceylon	16.2	39	5.3	1.8	1.9	4.1	11.9	66 3	14.17
China (Taiwan)	24.5	55	9.0	1.7	2.3	4.2	15.4	58 8	15 49
India	2.0	3	0.5	0.1	0.1	0.4	1.0	8.3	2 07
Indonesia	8.2	14	2 0	0.6	0.6	1.7	4 6	40 0	6 09
Korea, Rep. of	32.9	55	7.9	2.4	2.7	12.6	15.2	64 8	25 12
Malaysia-Singapore	29.6	45	6.5	2.0	2.0	3.9	12 3	48.5	18 90
Pakistan	3.1	5	0.8	0.2	0.2	0.6	1.7	8 1	2.27
Philippines	23.9	41	5.8	1.8	2.1	5.6	13 0	54.2	16 58
Thailand	22.5	38	5.4	1.7	1.8	5.4	12 0	59 3	15.80
Viet-Nam, Rep. of	12.4	29	5.2	0.7	1.4	3.3	11.5	49.5	10.21

SOURCE: FAO. *Agricultural commodities: projections for 1975 and 1985.*

even more — of the total amount of animal protein consumed is of fishery origin. The contribution of fish to total protein consumption in these countries ranges from 10 to almost 18 percent.

Compared with other countries in the Asia and Far East region, in India and Pakistan fish accounts for only a minor share of protein supplies. In the Near East and in South American countries with strong preferences for meat, fish protein has not so far played a very important role in nutrition.

The last column in Table 1 shows that the share of fish in the total monetary value of food at the primary producer's level varies from country to country in a manner similar to per caput consumption. In a few landlocked developing countries, the share is a fraction of 1 percent. Elsewhere it may rise to as high as one fourth, as is the case in the Republic of Korea.

2. TRENDS IN FISH PRODUCTION AND UTILIZATION

Production

Fishery resources are defined as the animal and plant life exploited (or potentially exploitable) for food or for nonfood industrial purposes in the three fourths of the surface area of the world occupied by ocean and inland water bodies.

The basic classification of resources is by species and groups of species. FAO distinguishes the following groups in its statistical compilations of catches and landings:

1. Freshwater and diadromous (species which migrate between salt water and freshwater bodies for spawning purposes, such as salmon, eels, shads, etc.) fishes.
2. Marine fishes.
3. Crustaceans, mollusks and other invertebrates.
4. Whales.
5. Seals and miscellaneous aquatic mammals.
6. Miscellaneous aquatic animals (e.g., turtles, frogs) and residues (pearls, shells, sponges, corals, etc.).
7. Aquatic plants.

With the exception of "residues," all groups can be utilized as food for man. Human consumption is the principal use for fish and shellfish (groups 1, 2 and 3 above). For the other groups, industrial uses are more important.

A constantly growing share of the fish used for food is processed in some manner. The operations range from beheading, eviscerating and filleting of fresh fish to what are sometimes fairly elaborate indus-

trial methods for making available to the consumer well-flavored, ready-to-serve dishes.

Industrial uses are numerous and diversified. Some products such as meals and oils produced primarily from marine fish and whales are used indirectly for food production. Meal plays an important role in pig and poultry feeding and oil is used in the manufacture, among other products, of margarine and shortening.

Aquatic vegetable products include seaweeds used primarily for human consumption or in the manufacture of glues and of media for bacterial growth such as agar (which also has uses in food and medicinal products). New uses in food and other industries are being developed.

To assess opportunities for development more must be known, as a rule, than the species composition of the fisheries catch. Information on the potential of a resource and on the relation between effort and catch is necessary, among other reasons, to determine whether it pays to exploit it commercially. Breakdowns by fishing areas, seasons of the year, size classes of individuals taken, production units and gear and fishing methods employed in capture, and landing districts, help in decisions on type and size of facilities for exploitation, handling and processing and on management methods.

Table 2 shows the trend in the catch of fish and shellfish since 1957-59. Total production expanded from 33.6 million metric tons in the base period to 52.4 million metric tons in 1965, the average annual rate of increase over the period being in the neighborhood of 7 percent. A large majority — about three fourths — of the total catch is made up of marine fishes. In 1965, the remainder was accounted for by freshwater and diadromous fishes with 13.7 percent; crustaceans, mollusks and invertebrates with 7.8 percent; and other species (divisions 4 to 7 in the FAO classification) with 1.4 percent.

Herrings, sardines, anchovies and related fishes have traditionally figured most prominently in fisheries catches. Because of the growth of fish meal and oil industries which use them as raw material, production of these species has tripled in recent years to almost 18 million metric tons in 1965, representing over one third of the total world catch. Ranking next in the marine fish catch total are the following groups: cod, hake, haddock and related species (over 6 million metric tons); red fish, bass, etc.; mackerel, billfish, etc.; tuna, bonito, etc.;

TABLE 2. – THE WORLD CATCH OF FISH, CRUSTACEANS AND MOLLUSKS

	1957-59 average	1961-63 average	1964	1965
	Thousand tons			
World total	*33 600*	*45 700*	*52 000*	*52 400*
DEVELOPED COUNTRIES	*17 830*	*20 230*	*20 800*	*22 560*
North America	*3 850*	*4 050*	*3 910*	*4 010*
Canada	1 020	1 114	1 211	1 259
United States	2 786	2 894	2 647	2 701
Western Europe	*7 610*	*8 200*	*9 130*	*10 150*
Norway	1 588	1 414	1 608	2 280
Spain	827	1 074	1 203	1 338
Iceland	575	776	973	1 199
United Kingdom	1 001	933	974	1 047
Denmark and Faeroe Islands	701	890	1 010	985
France	637	746	780	768
Germany, Fed. Rep. of	762	633	624	632
Portugal	458	522	604	554
Netherlands	311	343	388	377
Sweden	243	300	372	365
Italy	249	270	296	317
South Africa and South West Africa	660	1 080	1 260	1 340
Japan	5 600	6 760	6 350	6 910
Australia and New Zealand	110	140	150	150
DEVELOPING COUNTRIES	*8 220*	*14 960*	*19 580*	*17 630*
Latin America	*2 150*	*8 020*	*11 400*	*9 400*
Peru	1 220	6 382	9 116	7 462
Chile	237	610	1 161	709
Brazil	221	355	331	...
Mexico	158	229	249	256
Argentina	86	111	168	205
Africa	*1 390*	*1 420*	*1 630*	*1 580*
Angola	314	250	356	257
Morocco	159	178	200	215
Senegal	87	126	127	131
Near East	*380*	*430*	*480*	*510*
Far East	*4 300*	*5 090*	*6 070*	*6 140*
India	1 040	994	1 320	1 331
Philippines	437	516	624	686
Korea, Rep. of	402	487	602	640
Thailand	212	355	577	615
China (Taiwan)	228	330	377	382
Pakistan	286	332	361	379
Viet-Nam, Rep. of	144	295	397	375
CENTRALLY PLANNED COUNTRIES	*7 550*	*10 510*	*11 620*	*12 210*
China (Mainland)	4 067	...	...	...
U.S.S.R.	2 636	3 615	4 476	5 100
Poland	149	197	264	298
Eastern Germany	98	157	225	231

SOURCE: FAO. *Yearbook of fishery statistics 1965*, Vol. 20.

flounder, halibut, sole, etc.; and shark, ray, chimaera (none of the latter groups contributing more than 3 million metric tons).

Of the freshwater and diadromous fishes, only the group of salmon, trout, smelt, etc., the world production of which is below 1 million metric tons, has so far been of major significance in the establishment of processing operations. The bulk of freshwater fish catches are still used relatively close to landing places, making it possible to dispense with more elaborate provisions for preservation.

Crustaceans such as shrimp, lobster, etc., make up little more than one fourth of the total catch (1.2 million metric tons in the crustaceans, mollusks and other invertebrates group, with mollusks accounting for most of the remainder). Because of their high unit value, and because of the prominent place in the fisheries trade (especially in developing countries), catch figures do not adequately reflect the importance of crustaceans in the fisheries economy.

Estimates of the value of fisheries catches are harder to come by than of quantities taken. Apart from incomplete reporting of value data and the difficulty of bringing different national currencies under a common denominator, the lack of value information on the catches of countries with centrally planned economies, e.g., the U.S.S.R., makes it possible to arrive at only a very approximate indication of the total value of the world fisheries catch. On the assumption that countries for which value data are not available would value their catches on the same basis as other countries with a similar species composition, world production at the primary producer's level may be estimated to be worth from $7,000 to $8,000 million.

Value added from the time of landing to ultimate disposal is even more difficult to estimate, due to the large variety of industrial uses. For a complete assessment of the economic importance of fisheries, the income generated by the various input industries would also have to be estimated. Even in the absence of relevant statistical data it is evident, however, that fisheries occupy a much more prominent place in the world economy than the proportion of catch value to value of total gross product would indicate.

The Pacific Ocean is the source of nearly one half of the total world fisheries catch, with the greatest concentration of fishing in the western-central and southeastern parts. The Atlantic Ocean contributes about 38 percent, the fishing being heaviest in the northeastern

area. Compared with the Pacific and Atlantic Oceans, the fisheries of the Indian Ocean are of modest size, their share of the world catch being less than 4 percent.

Inland fish production is largest in Asia, where two thirds of all freshwater and diadromous fish are taken.

Asia is the leading producing continent. While somewhat lower than a few years ago, its share of the world fisheries catch is still close to two fifths. Another 30 percent of the world catch is landed by European (including U.S.S.R.) fishermen. Ranking after Asia and Europe are South America, North America, Africa and Oceania, respectively with 17.2, 8.5, 5.8 and 0.3 percent of the 1965 world catch.

Most pronounced has been the increase in South American catches which, as little as ten years ago, were only of minor significance in world fisheries. Peru has made the biggest strides as a result of the expansion of fishing for reduction purposes. In the U.S.S.R. and in Mainland China, too, production trends have been steeply upward.

Measured by the advances in fisheries development of Peru and Mainland China, the progress made by other developing countries appears more modest. Nearly all developing countries of Asia, i.e., India, the Philippines, Thailand, the Republic of Korea, China (Taiwan), Pakistan and the Republic of Viet-Nam, however, show a rising catch trend, chiefly of food fish (for domestic consumption or intra-regional trade) but also of higher value crustaceans and tuna which are exported to North America, Europe and Japan. Developing countries in other regions which have succeeded in expanding their fisheries production are the Central and South American shrimp-exporting countries and, on a relatively smaller scale, some countries on the African continent.

At least a dozen countries have fisheries catches exceeding 1 million metric tons. Peru's production in 1965 was approximately 7.5 million metric tons and the year before had reached a record total of 9.1 million metric tons. Japan and Mainland China also have fisheries crops above 5 million metric tons, and the U.S.S.R.'s production is rapidly approaching this level. Following these countries are the United States, Norway, South Africa, South West Africa, Spain, India, Canada, Iceland and the United Kingdom.

Utilization

Utilization may be discussed from two viewpoints: (*a*) type of transformation operations to which the resources are subjected; and (*b*) market characteristics of the products produced. A basic distinction is made between distribution as fresh fish, and utilization for freezing, curing, canning, reduction and other processing operations. While some fresh fish is retailed directly at the port, it is today more often " processed " in some form (beheaded, eviscerated, filleted, etc.) before sale to the consumer, especially in developed countries. In contrast, fish classed as " processed " fish often includes, especially in developing countries, products like sun-dried fish prepared in the most rudimentary fashion, without use of expensive capital equipment. Statistical totals for some processed products are likely to comprise commodities manufactured with elaborate and expensive equipment and methods as well as commodities produced by the most primitive means (thus, dried fish production totals, for instance, will not provide an indication of the proportions produced by simple sun-drying and by artificial dehydration, respectively).

A substantial portion of the fishery catch is processed in more than one way before reaching the consumer. This, too, tends to detract from the usefulness of a classification by type of transformation method. Thus, in some countries, cured and canned fishery products are manufactured increasingly (partly as a result of the growth of freezing at sea) from frozen rather than from fresh fish. In many instances, freezing operations are carried on today to ensure stability and regularity of raw material in the manufacture of more elaborately processed products to supply the frozen food market.

When considered from the standpoint of final product use and market acceptance, the following utilization patterns can be distinguished: reduction and miscellaneous other industries manufacture, in general, products not destined for direct human consumption; freezing, canning, salting and other forms of curing operations, by comparison, are carried out to preserve fishery resources for the food market. Still, while the fish meal and fish oil produced by the reduction industry is at present used virtually exclusively in animal feeding, experiments are under way to manufacture and distribute a fish protein concentrate which meets the nutritional and economic require-

ments of the market for food products. Nor is all of the production of the food-processing industries disposed of for human consumption; sizable segments of the fish-canning industry, for instance, serve the pet food market.

The distinction between products for human consumption and those destined for industrial uses is important, since the demand for the intermediate products in the latter category is dependent on conditions in end-product markets. For products sold for direct consumption, it is useful to make a further distinction between " staple " and " luxury " type products, because of substantial differences in the character of the demand. Here again, classification by type of transformation operation is not sufficiently revealing: while in higher income countries some canned fish products are classed as " inferior " products, the consumption of which tends to decline with rising incomes, sales of other canned fish products, e.g., of preferred varieties of canned tuna and canned salmon, increase quite significantly when improved living standards enable additional consumers to become more discriminate in their food purchases.

Table 3 gives details for the disposition of world fisheries catches in 1957-59, 1961-63, 1964 and 1965. Over the period covered, reduction and freezing operations have made relative gains. The increase in utilization was most pronounced in the case of reduction. Canning operations accounted for about the same share throughout the period; the shares used as fresh fish and for curing declined.

TABLE 3. – DISPOSITION OF THE WORLD CATCH OF FISH, CRUSTACEANS AND MOLLUSKS

	1957-59 average	1961-63 average	1964	1965
	Thousand tons			
Total catch	33 600	45 700	52 000	52 400
DISPOSITION	*Percentage*			
Marketing fresh	43	37	34	33
Freezing	8	9	10	11
Curing	22	18	16	16
Canning	9	9	8	9
Reduction to meal, oil, etc.[1]	15	25	30	29
Miscellaneous purposes	3	2	2	2

SOURCE: FAO. *Yearbook of fishery statistics 1965*, Vol. 20.

[1] Includes whole fish destined only for the manufacture of oils and meals.

If one assumes, for convenience, that the supplies used for fresh marketing, freezing, curing and canning are destined for human consumption, and the supplies for reduction and miscellaneous purposes, for industrial uses, the data show that, in 1965, almost seven tenths of the world fishery production was used directly for food purposes as against 82 percent in the years centered on 1957-59. The comparison should not be interpreted necessarily as a reliable clue on future trends; it illustrates the startling growth of the reduction industries of Peru and Chile during this period, possibly a unique occurrence in fisheries development.

Geographically, utilization patterns are as follows. For fresh fish marketing, a cool climate, short distances to large markets and good infrastructure facilities for the distribution of highly perishable foods are essential. Fresh fish has maintained its market position in developed countries where these conditions obtain, e.g., in the United Kingdom and in Scandinavia. Fresh fish consumption is considerable, however, also in some tropical developing countries where fish not eaten on the day of capture must be preserved in some fashion. These countries usually have either many small inshore marine fisheries extending along their coastlines or inland water fisheries not too distant from market centers, making possible disposal of a sizable share of catches as fresh fish.

Frozen fish distribution has expanded most rapidly in countries where, at the time new fish-freezing facilities were created, a cold chain was already in existence to handle the output of the industry. The United States, Japan, the U.S.S.R. and the countries of western Europe lead in the consumption of frozen products, obtaining supplies from their own industries as well as from producers in the north such as the Scandinavian countries and Canada.

The high-income countries also are the principal markets for canned fishery products. The United States is the chief consumer of canned tuna and canned salmon. Canned herring and sardines are consumed widely throughout North America and Europe. While still limited on an overall basis in the developing areas, consumption of cheaper varieties of canned fish is relatively high in some countries, e.g., in the Philippines. Morocco and Peru are two developing countries which produce sufficient quantities of canned fish to have a surplus for export.

Cured fish production and consumption is on the decrease in most developed countries but remains important in developing countries. The simpler methods of salting, drying, smoking, pickling and fermenting are less costly than other processes and the products, therefore, best suited for low-income markets. Climate and the availability of preservative materials influence the type of cure used. Existing consumption patterns sometimes impede the introduction of new cures.

3. FISHERY COMMODITIES: PRODUCTION AND TRADE

Fish-processing operations range from primitive, subsistence type sun-drying requiring virtually no capital investment, to modern large-scale freezing, canning and fish-meal industries. In developed countries, small-scale local processing survives only in isolated coastal areas where a large part of the population depends on fishing, and where communications to major market areas are inadequate. Area development programs seek to replace such operations with up-to-date industries which are able to compete with food-processing industries manufacturing products the consumer tends to substitute for fish (red meat and poultry products).

A basic factor determining utilization and needs for processing of fishery resources is the size of the catch measured against the market absorption capacity for fresh fish. The smaller the latter in relation to supplies, and the greater the distance of markets from landing points, the more extensive are the provisions that must be made for the preservation of the fish. Other factors influencing utilization are seasonal fluctuations in consumption, changes in consumer habits and preferences, and changes in consumer purchasing power.

Seasonal and secular patterns are also recognizable on the supply side. They are related both to the behavior of the individual species and to factors governing fishery exploitation (the radius of fishing operations, management controls, etc.).

In some areas, processing operations have not expanded as rapidly as might have seemed warranted by the rate of catch increase. The extensive development of refrigerated facilities in ships, of ice plants and cold storage, and of refrigerated land transport may have made it possible to handle larger quantities of fresh fish. Elsewhere, especially in developing countries, lack of investment capital for processing has

been, and continues to be, a major factor holding back development of manufacturing facilities. In most developing countries, low purchasing power and relatively fixed food preferences of consumers are other factors which have prevented the expansion of markets for fishery products manufactured on a more ambitious industrial scale.

The above notwithstanding, the need for products with a longer shelf life as well as technological advances have led to a considerable growth of fish-processing operations on a world basis in recent years. The long-term trend indicates that manufacturing will expand more rapidly than fresh fish marketing.

Some fish species are easier to process in one way rather than in another. In general, lean fish are less suitable for canning than fat fish. Fish low in fat content, on the other hand, are more suitable for drying, since reduction of the water content does not prevent oxidization of the fat.

Apart from fat and water content, size also is a factor in determining suitability for certain processing operations. Thus, small fish and shellfish often cannot be economically filleted, deveined, etc., and are, as a rule, preserved by simple methods not requiring expensive capital equipment.

The FAO *Yearbook of fishery statistics* (Volome 21) groups statistical data on the production of preserved and processed fishery commodities under the following seven major classes:

1. Fish, fresh, chilled or frozen
2. Fish, dried, salted or smoked
3. Crustaceans and mollusks, fresh, frozen, dried, salted, etc.
4. Fish products and preparations, whether or not in airtight containers
5. Crustacean and mollusk products and preparations, whether or not in airtight containers
6. Oils, fats, crude or refined, of aquatic animal origin
7. Meals, solubles and similar animal feedingstuffs, of aquatic animal origin

For groups (1) and (3), only incomplete information is available, because of difficulties in separating fish and shellfish marketed fresh from products sold in frozen form.

TABLE 4. – PRODUCTION OF, AND INTERNATIONAL TRADE IN, FISHERY COMMODITIES

(1965 and percentage changes since base period of series)

Commodity	1965 production	Percentage change in production (1957-59 base)	1965 exports	Percentage of production exported	Percentage change in share of production exported (1958 base)
	Thousand metric tons		*Thousand metric tons*		
(1) FISH, FRESH, CHILLED OR FROZEN	...	...	*1 565*	...	64
Herring, fresh or chilled	...	...	365	...	72
Miscellaneous fish products, fresh or chilled	...	...	341	...	35
Fish fillets, fresh or chilled	100	127	20	20	82
Fish fillets, frozen	472	75	286	61	64
Herring, frozen	104	22	74	71	54
Miscellaneous fish products, frozen	3 425	169	356	10	95
(2) FISH, DRIED, SALTED OR SMOKED	*2 903*	2	*506*	*17*	– 17
Stockfish (cod and similar species, dried, unsalted)	39	– 28	38	97	– 12
Cod, hake, haddock, etc., salted	407	11	176	43	– 15
Herring, dried or salted	767	– 8	75	10	– 52
Sardines, anchovies, etc., dried or salted	222	– 10	3	1	– 57
Miscellaneous fish products, dried or salted	1 170	5	145	12	27
Herring, smoked or smoked-frozen	62	3	14	23	– 22
Miscellaneous fish products, smoked or smoked-frozen	236	31	2	1	100
(3) CRUSTACEANS AND MOLLUSKS, FRESH, FROZEN, DRIED, SALTED, ETC.	...	...	*291*	*46*	*60*
Crustaceans and mollusks, alive, fresh, chilled, etc.	...	...	...	...	...
Crustaceans, fresh, frozen, dried, salted, etc.	250	63	81	32	37
Mollusks, fresh, frozen, dried, salted, etc.	380	79	113	30	40
(4) FISH PRODUCTS AND PREPARATIONS, WHETHER OR NOT IN AIRTIGHT CONTAINERS	2 957	49	*526*	*18*	*11*
Pacific salmon, in airtight containers	137	– 6	61	45	– 31
Herrings, sardines, anchovies, etc., in airtight containers	535	11	175	33	– 4
Tunas, bonitos, skipjacks, in airtight containers	348	34	62	18	24
Miscellaneous fish products, in airtight containers	682	59	142	21	42
Fish preparations, not in airtight containers	1 255	91	43	3	105

TABLE 4. – PRODUCTION OF, AND INTERNATIONAL TRADE IN, FISHERY COMMODITIES (*concluded*)

(1965 and percentage changes since base period of series)

Commodity	1965 production	Percentage change in production (1957-59 base)	1965 exports	Percentage of production exported	Percentage change in share of production exported (1958 base)
	Thousand metric tons		*Thousand metric tons*		
(5) CRUSTACEAN AND MOLLUSK PRODUCTS AND PREPARATIONS, WHETHER OR NOT IN AIRTIGHT CONTAINERS	*150*	*46*	*58*	*39*	*53*
Crustacean products, in airtight containers	50	43	22	44	22
Mollusk products, in airtight containers ..	95	46	22	23	69
Crustacean and mollusk preparations, not in airtight containers	5	67	...	...	...
(6) OILS, FATS, CRUDE OR REFINED, OF AQUATIC ANIMAL ORIGIN	*1 118*	*26*	**761*	**68*	**35*
Whale oil	198	– 49	187	94	24
Sperm oil	142	25	39	27	2
Whale liver oil	...	...	...	...	...
Fish liver oils and similar products	60	– 6	26	43	30
Fish body oils and similar products	710	131	445	63	220
Miscellaneous oils and fats of aquatic animal origin	8	– 47	3	37	– 40
(7) MEALS, SOLUBLES AND SIMILAR ANIMAL FEEDINGSTUFFS, OF AQUATIC ANIMAL ORIGIN	*3 694*	*128*	*2 431*	*66*	*261*
Meat meals, liver meals, and solubles from whales	83	– 4	14	17	77
Fish meals from "white fish" ("ground fish")	285	42	69	24	29
Fish meals and solubles from oily fish ...	3 313	151	2 282	69	357
Miscellaneous meat meals and solubles of aquatic animal origin	13	8	1	8	0

SOURCE: FAO. *Yearbook of fishery statistics 1965*, Vol. 21.

* Data for group total refer to imports.

Statistical data on the production and international trade in fishery commodities is summarized in Table 4. The table shows 1965 production and export figures for the seven FAO groups as well as for the principal items within each group. Additional data shown in the table include the proportion of production destined for export as well as data on trends in production and in the relative importance of the export trade.

To reconcile fishery resource utilization and fishery commodity production statistics, due account would have to be taken of processing yields. The latter differ considerably for various transformation methods and species.

The fish-freezing industry

The rapid expansion of the fish-freezing industry in recent years has been influenced by both supply and market factors. On the market side, the general trend in demand toward prepackaged frozen food, and the wider diffusion of frozen food storage facilities in wholesale and retail establishments and in the home, have increased the distribution potential. At the same time, extension of the radius of fishing operations, with larger craft making longer trips, has made it necessary to seek ways of preserving catches on board by better methods than simple packing in ice; in many instances, this has been accomplished by freezing fish at sea. Much of the sea-frozen fish is sold in frozen form, although some of the frozen landings, especially in some fisheries and in some countries, are canned (e.g., tuna in the United States) or cured in some form. In some cases, sea-frozen fish is sold as "fresh fish" after thawing on land.

Processing at sea rarely extends to the preparation of consumer packages. The fish which is bulk-frozen at sea for eventual processing in shore plants into canned, smoked and other products is thawed on landing before it is further processed. Even most of the bulk-frozen fish that is eventually retailed in frozen form is thawed, filleted on shore, refrozen and packaged, either in larger institutional or smaller consumer-size packs.

Freezing is at present the only method which can preserve the fresh fish characteristics during long storage. In addition, it offers,

if applied on a large scale, the following advantages common to industrialized processing:

(*a*) consistent quality;
(*b*) product variety;
(*c*) possibility of stabilizing supply and price;
(*d*) hygienic packaging and distribution;
(*e*) standardization of product type;
(*f*) extension of range of retail outlets;
(*g*) creation of an incentive for manufacturers to use modern advertising.

The above factors account for the growing interest, in developing countries, in the establishment of fish-freezing plants and frozen storage facilities. On the other hand, the initial capital investment is high and the costs of storage and distribution are substantial. The economic feasibility of the marketing of frozen fish, therefore, is directly related to the capacity and geographical range of cold storage and transport facilities, both at the wholesale and retail stages and, to some extent, also to the amount of refrigerated storage space in consumer homes and in institutions. In the absence of a cold chain, the economic implications of establishing a chain based on frozen fish distribution alone must be carefully assessed. Usually costs are too high; opportunities for frozen fish distribution are thus largely determined by the stage of development of the frozen food industry.

Costs of freezing and cold storage facilities and operations can to some degree be reduced at the expense of quality. Quality requirements are determined in terms of what is accepted by the market (and what is considered safe from the standpoint of health by the authorities) rather than in terms of any universally applicable standards. There is an economic limit, however, beyond which the savings achieved, e.g., by using freezing or storage temperatures higher than those necessary for the production of products of good quality, will not " pay." This point is reached when financial losses attributable to spoiled products which have to be discarded or to lower receipts for inferior quality merchandise will exceed the savings realized by the lowering of technical standards.

Fish-freezing operations are considerably more important than statistical information on catch utilization indicates. This is, as previously mentioned, because of the further processing of frozen fish into canned, cured and other products.

Statistical data on fish-freezing operations

The U.S.S.R. and Japan together accounted for about one half of the 5.7 million metric tons of fish and shellfish which were utilized for freezing in 1965. Canada's share was close to 8 percent in recent years and that of the United States over 5 percent. Large-size freezing operations are carried on also by Iceland, Norway, the Federal Republic of Germany, the United Kingdom and Denmark.

In Canada, over one third of the total quantity of fish and shellfish caught is preserved by freezing; in the U.S.S.R. 30 percent and in Iceland 18 percent.

The commodity group, *Fish, fresh, chilled or frozen,* comprises a large variety of products, as can be seen from the production total for products classed as miscellaneous frozen fish products in Table 4. Frozen fish fillets, prepared mostly from cod, hake and haddock are of special importance in international trade.

In 1965, the leading producing countries reported a total production of nearly 500,000 metric tons in net product weight of frozen fish fillets. Stated in round weight terms, this output would be much larger, since filleting wastes are over one half the fresh fish weight. Production of frozen herring was in excess of 100,000 metric tons, and production of miscellaneous other frozen fish in the neighborhood of 3.5 million metric tons.

The leading producers of frozen fish fillets are Canada, Norway, the United Kingdom, the Federal Republic of Germany, Iceland, the United States and Denmark. The same countries, with the exception of the United States, which are by far the most important customers for frozen fillets, are also the leading exporters. Over three fifths of frozen fillet production is exported. In 1965, these exports were valued at $157 million, representing about 8.2 percent of the total trade in fishery products.

The bulk of frozen herring production is accounted for by the

Scandinavian countries. Nearly three fourths of the output is exported, to a large extent to eastern European countries.

Production of miscellaneous frozen fish products is spread over a much larger number of countries. The U.S.S.R. and Japan produce over 85 percent of the world output, mostly for domestic consumption but, in the case of Japan, also for export.

To date, developing countries have played only a minor role in the production and trade of frozen fish. Freezing operations, however, are expanding relatively rapidly in some regions, in particular in South America and in Southeast Asia (in the Republic of Korea, China [Taiwan] and other countries). Products prepared from tuna and tuna-like species, which for the most part are exported, are of special importance for the fishery industries of these countries.

Data on frozen shellfish production and trade are included in the totals for commodity group (3), *Crustaceans and mollusks, fresh, frozen, dried, salted, etc.*

In 1965, the output of processed crustaceans (including products marketed fresh, after peeling or other "processing") reached 250,000 metric tons, the output of processed mollusks (including products marketed fresh, after shucking or other "processing") 380,000 metric tons. Production was 63 percent higher for processed crustaceans and 79 percent higher for processed mollusks than in the 1957-59 base period.

In value terms, the most important product in commodity group (3) is frozen shrimp. In terms of weight, the production of Japanese frozen squid exceeds that of any other product.

Shrimp are fished in all parts of the world, mostly in nearby marine waters. Production has expanded greatly in recent years in response to a rising demand in high-income countries, particularly in the United States. The latter is not only the largest importer but also the leading producer of crustacean products. In 1965, its production of processed shrimp products alone exceeded one fifth of the total quantity of crustacean products produced in the world. In addition to shrimp, the United States produces and/or imports a variety of other high unit-value crustacean and mollusk products, processed from crab, lobster, spring lobster, scallop, oyster, clam and abalone resources.

One third of the production of processed crustaceans, and only a slightly lower proportion of processed mollusks, are exported.

Total 1965 exports of processed crustaceans and mollusks were valued at $270 million, representing about 14.1 percent of the world trade in fishery products. In 1964, a total of 66 countries, nearly all from developing areas, supplied shrimp, for the most part in frozen form, to the United States. The exports of crustaceans and mollusks of developing countries to the United States in the same year were valued at $122 million and constituted 80 percent of the value of the total exports of crustacean and mollusk products of developing countries. The leading exporter is Mexico, which has an important shrimp industry.

Next to the United States, Japan and France have the largest import demand for crustacean and mollusk products.

Japan imports substantial quantities of cured as well as frozen shellfish products.

The fish-curing industry

The concept "curing" comprises a variety of processing techniques aiming at the preservation of raw material by dehydration or addition of chemical substances, or both. Additives and chemical changes effected during curing often impart a desired flavor to the product.

Drying

Drying, either alone or in combination with salting or smoking, or in combination with both, still accounts for the largest share of the fish catch used for processing for human consumption.

Drying does not succeed as well as freezing in preserving the characteristics of fresh fish. This, to a large extent, explains the relative growth in importance of freezing and the relative decline of drying operations. Low cost of preparation, transport and storage, however, assure dried products of the staple variety an important place in the markets of many developing countries for a long time to come. One major drawback is that dried products are easily infested by insects if not properly processed and stored.

With the exception of drying racks and storage facilities, no capital equipment is needed for the production of dried fish by natural air-drying. Dehydration (artificial drying) differs from natural drying insofar as

it is a process which aims to reduce water content under carefully controlled conditions, generally by mechanical means, so that the effect on appearance, odor, flavor, texture and nutritive value following reconstitution is minimized. Therefore, the costs of preparation, and often also of packaging and storage, of dehydrated products are usually higher than those of naturally dried products.

Salting

While salt is often used either as a condiment or an auxiliary preservative in other processes of fish preservation, " salting " is the process in which it is the chief preservative. Markets for salted fishery products have been on the decline in developed countries as a result of changes in dietary habits and increased utilization for freezing of species at one time processed primarily into salted fish.

Salts acts as a preservative by extracting water from the raw material. Quick penetration of the salt into the tissues of the fish is desirable to protect quality. Climatic conditions, the quality of the salt used for processing, and the character and size of raw material supplies are among the factors influencing the choice of a processing method.

Smoking

In smoking operations, preservation is achieved by a combination of drying and deposition of chemicals which are contained in the smoke of burning wood. Cooking fish over an open fire makes it keep longer and adds a distinctive flavor, which varies with the kind of wood burned and with the other conditions of the process, e.g., the time/temperature relation under which the smoking is carried out.

Traditional smoking operations differ substantially between different geographic areas and ethnic groups, as well as according to type of fish used, quantity processed and material available locally for the construction and operation of ovens. The more primitive ovens are small wooden or metal grids on which the fish is cooked and smoked in the open air. These ovens are built at virtually no cost by the fishermen and their families; the volume of production is merely sufficient to cover home consumption requirements although, where premium inland species constitute the raw material, the fish is often sold.

The mechanical smoking of fish, under controlled processes, requires equipment to regulate the principal variables in smoking, namely, smoke volume and quality, temperature, humidity, velocity and distribution of air and smoke. This type of smoking has come into use comparatively recently and requires expensive installations and highly qualified operators compared with traditional smoking operations. On the other hand, it provides the possibility of producing products of a much more uniform quality, in larger quantities in place and time, and at a substantially lower rate of firewood consumption; it is practically independent of climatic conditions.

Other curing operations

Semiconserves or marinades are cured fish products which enjoy considerable popularity in some developed countries, notably in the Scandinavian area, the Netherlands and in Germany. They are produced by treating the raw material with vinegar and salt and are characterized by typical odors and flavors (accentuated by the addition of spices and covering liquids). Keeping quality is limited since, for reasons of taste, it is not possible to increase the amount of additives sufficiently to prevent spoilage for extended periods of time. Cold, fried and cooked marinades are distinguished; processing procedures vary substantially.

Fermented seafoods and fish sauces and pastes are regional favorites in Southeast Asia. While for the most part requiring only the most rudimentary facilities and equipment for processing, curing procedures are often rather involved and time-consuming. A large part of the production is of subsistence character and there is considerable variety in products and processing methods. Where commercial operations are carried on for the production of individual products such as, for instance, the popular fish sauce nuoc-mam, large vats with bamboo taps fitted near the bottom are used in some areas.

Statistical data on fish-curing operations

The Far East leads the other regions of the world in the utilization of catches for curing operations. In 1965, Japan alone accounted for more than 40 percent of the 8.1 million metric tons of fish and

shellfish used for curing in the world. Curing is of considerable importance also in all other Far Eastern countries.

The U.S.S.R. ranks after Japan in fish-curing operations. In Europe, the leading producers are Norway, Iceland, Spain and Portugal; in North America, Canada.

Curing is the principal fish-processing activity in a number of African countries, e.g., in Cameroon, Tanzania and Uganda. In Portugal, the bulk of fish production is used for curing.

Salted, dried unsalted, and dried salted products make up the bulk of the output of products in product group (2), *Fish, dried, salted or smoked.* Smoked products represented about one tenth of the total, which in 1965 amounted to 2.9 million tons.

Dried or salted herring, sardines, anchovies, etc., and salted or unsalted cod, hake, haddock and related fish are the most important products and together account for about half the total production.

The U.S.S.R. is the leading producer of cured herring products, followed by Poland. Japan produces a miscellany of cured products, including a substantial quantity of semiconserves, which in FAO statistics are included in commodity groups (4) and (5).

Poland ranks second after the U.S.S.R. in the production of cured herring. Spain, Portugal and Canada concentrate on the manufacture of (salted) cod products, while Iceland and Norway are important in the production of both herring and cod products.

Exports of products in commodity group (2) were valued at close to $214 million in 1965. The products of special importance in international trade were:

1. *Salted products manufactured from cod and related species*, which accounted for about two fifths of the total value of exports. Characteristic flows in this commerce are from Canada to countries in the Caribbean area and from Norway, Iceland and the Faeroe Islands to Spain, Portugal, Brazil and Italy.

2. *Stockfish* (*dried unsalted cod*). Virtually the entire world output, produced by Norway and Iceland, is exported to West African countries.

3. *Dried or salted herring.* About one tenth of world production is exported. The principal exporting countries are the Netherlands

and the Scandinavian countries, and the best customers are the eastern European countries and the Federal Republic of Germany.

4. *Miscellaneous dried or salted fish products.* Again, roughly one tenth the output is destined for markets abroad. Several characteristic trade flows are distinguished. Spain exports a substantial quantity of "bacalao," mostly to Italy; the U.S.S.R. has an export trade in dried fish with several eastern European countries; Pakistan and India supply dried fish to Ceylon; and in Africa, Angola, Mali and several other countries export dried fish to their neighbors.

The fish-canning industry

While it is not increasing as rapidly as freezing, the preservation of fish by canning is steadily expanding, among others for the following reasons: availability of larger and more regular raw material supplies (by virtue of the extension of the radius of fishery operations and the use of refrigeration on board vessels); development of canning operations at new locations; increased mechanization of handling and processing operations; greater variety of packs and, as a consequence, better acceptance of canned products in the market.

For the marketing of canned fishery products, no special facilities are required. The keeping qualities of adequately sterilized products are almost unlimited, and the products can be distributed at low cost to consumers through an existing transport and storage network. Canning also offers wide scope in adapting products to specific consumer preferences in respect of texture, taste and flavor.

Development of fish-canning operations is frequently held back by the high cost of tin plate required for the containers. In low-income countries, the high cost of the container may more than cancel the cost advantages on the storage, transport and marketing side, and may make canning operations less attractive to the entrepreneur than other fish-processing operations.

As in other fish-processing operations, complexity of facilities and methods in seafood canning may vary considerably, depending on market requirements and on the resources available for the develop-

ment of the industry. More elaborate arrangements are necessary for packs which are sold in the quality-conscious markets of developed countries. High labor costs in the same countries may favor mechanization of operations. If the pack is seasonal, however, mechanization cannot be carried very far, since expensive machinery would have to lie idle for extended periods of time. In developing countries, too, canning operations tend to be labor-intensive because of the relatively high cost of equipment.

There is some concern over the future of the trade in canned fishery products of the "staple" variety. Markets may be weak because, in developed countries, the demand for these products is characterized by lower income elasticity than that for high-grade fresh and frozen fishery products. At the same time, in developing countries most canned products will continue to be too expensive for the average consumer, preventing expansion of the market on a scale that might fully compensate for the downward trend in developed countries. Canned fish is likely to enjoy a growing demand, however, in those developing countries where the very exacting transport of cooled and frozen foods is not yet available but where the public taste is changing, as it already has in many developed countries, from a preference for dried, smoked and salted fish to more mildly flavored products.

A few basic conditions should be met if canning is to be introduced. These are:

1. Fish species suitable for canning should be available, in sufficient quantity and of adequate quality, at regular intervals and reasonable prices.

2. Products acceptable to the consumer must have been developed so that no difficulties are encountered in finding market outlets for the pack.

3. There must be access to adequate communications and energy and water sources.

4. There must be a relatively large supply of unskilled labor that can be rapidly trained to perform the bulk of the canning operations not requiring special skills, and a small number of highly skilled personnel for supervisory and technologically specialized jobs.

The data for commodity groups (4) and (5) in Table 4 relate primarily to fish and shellfish put up in airtight cans. Other products included are semiconserves such as marinades, fermented fish, fish pastes and fish sauces.

Total production was in excess of 3.1 million tons in 1965. Shellfish products represented less than 5 percent of total output. The species principally used for canning are herring, sardines, anchovies, etc., tuna and tuna-like fish and salmon. The varieties of shellfish used for canning are primarily crab, shrimp, clams and oysters.

The leading producers of canned herring and sardine products are the Federal Republic of Germany, the U.S.S.R., South West Africa, Portugal, Morocco, Norway and Spain. In the packing of tuna and tuna-like species the United States is dominant, with Japan and Italy following at some distance. The United States leads in salmon canning, which is of considerable importance also in Japan, the U.S.S.R. and Canada. Japan, in addition to tuna and salmon, cans a variety of other species, notably mackerel, and produces the bulk of fish preparations not put up in airtight containers.

The United States and Japan lead in the manufacture of canned shellfish products; a large number of other countries have industries of smaller size.

All products in commodity groups (4) and (5) are exported in significant quantities, except fish preparations not put up in airtight containers. In 1965, the total value of exports was in excess of $390 million.

The principal trade flows are as follows: Japan, Canada and the United States account for the bulk of canned salmon exports destined, for the most part, for United Kingdom and Australian markets. Portugal, Morocco and Norway account for over two thirds of all exports of canned products produced from herrings, sardines, anchovies, etc., which are sold in all parts of the world. Japanese canned tuna is sold chiefly in the United States and in a few European countries, including the United Kingdom and the Federal Republic of Gemany.

Characteristic flows in the trade of canned fish products in the " miscellaneous " category are the Japanese exports of canned mackerel

to the Philippines, and exports from the U.S.S.R. to eastern European countries.

Japan and the U.S.S.R. are the chief exporters of canned crustaceans, primarily crabs and crabmeat.

The fish-reduction industry

Reduction operations are based on utilization of fishery resources which can be used more profitably for industrial than for human consumption purposes. Reduction raw material is composed, therefore, primarily of fish which is not eaten by or has little appeal to consumers, excess catches which cannot be processed and distributed economically for human consumption, and offal from fish-processing operations.

Industrialization started with the use of catch surpluses for the production of fish oil and fertilizer. Later developments were the use of " fish scrap " and fish meal for animal feed. Today the principal commercial products of the reduction industry are meals, oils and solubles, fish meal being by far the most important product. In the future, manufacture of edible fish protein concentrates can be expected to account for a growing share of industrial processing operations.

Fish meal

While the fish meal industry had its origin in the reduction of waste material from other fish-processing operations, today larger scale operations are based on the utilization of whole fish. Production has expanded in spectacular fashion in recent years. This development has largely been due to the advance of scientific farming and the increased use of fish meal as a component in pig and poultry feeding. Apart from its unique value as a nutritive element in feeding, cost factors contributed to the preference of feed compounders for fish meal over other components. It was fortunate for the industry that, at a crucial time from a market standpoint, large quantities could be produced and delivered to markets at low prices because of the availability

of substantial stocks of "industrial type" fish, like the anchoveta off the Pacific coast of South America, which previously had been "harvested" only by the guano birds.

Fish oil

In many countries, and for many years, oil was the principal product of the fish-reduction industry. Fish body oils are being used in Europe primarily in margarine and other human food production, whereas in the United States they have markets in the manufacture of various industrial products, including soaps, paints and varnishes, floor covering and oilcloth, etc. In all uses there are competing products. Price factors, consequently, are a dominant element in the market.

Because of the steeply rising demand for fish meal, fish oil has virtually dropped to the position of a by-product of the reduction industry in some countries, e.g., in Peru. Elsewhere, notably in the United States and in the Scandinavian countries, however, it continues to be of great importance from the standpoint of the overall economics of reduction operations.

In general, processing yields vary with a large number of factors, among them the species of fish used as raw material; for individual species, with season, sexual maturity, temperature and feeding conditions; and with the processing methods used.

In Peru, the oil yield, although it has been slowly rising with the introduction of improved processing methods, still averages little more than 2 percent; in the Scandinavian countries and in the United States, which utilize raw material of higher fat content and which have important overseas markets for their oil production, it has been several times as large.

With the exception of the United Kingdom, whose fish-reduction industry depends to a large extent on white fish-processing offal for raw material, the major fish meal and fish oil-producing countries primarily utilize in their reduction operations species considered less suitable for food purposes. In 1965, Peru alone used almost one half (in 1964 two thirds!) of the total quantity of world "industrial" fish catches to supply its industry. Norway, South Africa and South West Africa, the United States, Iceland, Japan, Chile and Denmark are the

other countries with large meal and oil-manufacturing industries. In 1965, these countries together accounted for 35 percent of total catch utilization for reduction purposes.

Statistical data on fish-reduction operations

The principal products of the reduction industry are fish meals from white fish and oily fish (with a production in 1965 of about 3.7 million tons in net product weight), fish body oils and similar products (1965 production: 710,000 tons), whale (baleen) oil (1965 production: 198,000 tons) and sperm oil (1965 production: 142,000 tons). Products of secondary importance are whale liver oils, fish liver oils and miscellaneous oils and fats of aquatic animal origin (including seal, dolphin and squid oils).

The large-scale expansion of Peruvian reduction operations began roughly ten years ago, at a time when the country produced no more than 30,000 tons of meal a year. Today, with a production of approximately 1.5 million tons, nearly all of which are exported, the country is the leading supplier of world markets. In 1965, Peru's fish meal exports represented over half of total world exports of fish meal of over $300 million. The principal markets for Peruvian fish meal are in the United States and in western Europe, particularly in the Federal Republic of Germany. The United Kingdom is the best customer of Norway, South Africa, South West Africa and Iceland, which rank after Peru as fish meal exporters. Chile, Denmark, Angola and Canada are other leading fish meal exporters, the last-named country supplying mostly the United States. Japan was at one time a net exporter of fish meal; in recent years, it has had to cover a part of its own growing supply needs through imports, mostly from Peru and South Africa.

Altogether, about two thirds of the total production of fish meal is exported.

Marine oil production from all sources exceeded 1.1 million tons in 1965. Production has remained fairly stable in recent years. Over two thirds of the world marine oil production is exported.

Peru, Norway, the United States, Iceland, South Africa and South West Africa lead in the production of fish body oils. The first three countries are also the principal exporters. The largest import markets are in the countries of the European Economic Community and in Scandinavia.

Processing at sea

Processing of fish and shellfish at sea has greatly expanded in recent years. It is improbable, however, that this trend would ever lead to the abandonment of processing operations on shore.

Processing aboard vessels has been encouraged by the extension of the radius of fishing operations. This development, in turn, is due to several factors: depletion of stocks in nearby waters, extension of legal fishery limits excluding fleets from traditionally fished grounds, short fishing seasons attributable to natural phenomena (availability of fish on the grounds for short periods only) or to regulatory provisions, etc. In addition to the above, increased processing at sea reflects also the general growth in the utilization of catches for other than fresh fish marketing.

Processing at sea adds another dimension to the three functions normally performed by craft employed in fisheries operations (i.e., catching of fish, carrying of crew and equipment to and from the fishing grounds, and transport of the catch to port). If all of these functions are carried out by one vessel, technical efficiency has to be sacrificed to a certain extent and operational costs are higher than when the functions are separated among different craft. In particular, processing facilities reduce the amount of space available for crew accommodation and transport of catches. Where warranted by the size of operations, arrangements for processing at sea are most satisfactory, therefore, if organized on a fleet basis, with catcher vessels, mother ships processing the catches, and auxiliary craft delivering supplies and transporting to port products (as well as crews entitled to vacations). Operations of this type are floating industrial complexes and are in a position to stay indefinitely, or at least until major overhauls become necessary, in the vicinity of the fishing grounds. Completely integrated fleets can be maintained only by enterprises with considerable capital resources, and are economically feasible only where the likelihood of maintaining operations at close to full capacity exists. Organizing the transfer of catches to mother ships and performing work in rough weather conditions are among the major problems encountered in processing at sea.

Compromise arrangements, where processing is carried out together with other functions, become necessary for smaller operations.

These are often far from ideal for the conduct of efficient operations since, in addition to accommodation and provisions required for fishing operations, space for the processing equipment and working space and accommodation for the processing labor have to be provided, as well as large carrying capacity to store water, fuel, supplies and end products.

Where crews are kept at sea for extended periods of time, a serious morale problem arises. In the more advanced developed countries, high monetary incentives may have to be offered to induce crews to stay out at sea for several months. On the other hand, working conditions and crew accommodation, as well as recreational facilities, on large well-equipped factory ships may be far superior to those found on the average offshore fishing craft. In some instances these factors facilitate recruitment.

In recent years, the two most spectacular developments in fish processing at sea have been the rapid expansion of stern-fishing freezer-trawler operations and the organization, in the industries of the U.S.S.R. and of Japan and, to a lesser extent, also of Spain, of fishing fleets with mother ship and fish transport vessels. Salting aboard vessels in the western parts of the North Atlantic, and tuna freezing on tuna clippers and purse seiners are other important examples of processing operations at sea, as are whaling operations.

Processing at sea is uneconomical in most operations carried out at relatively short distances from shore. Exceptions are, perhaps, " mobile sea factories," where the establishment of shore plants appears impractical. The additional cost of a mobile factory over a shore plant may be offset by the possibility of extending the season or by the opportunity to exploit a resource which otherwise would not be utilized at all.

Ancillary facilities

Modern fish catching and processing industries depend on the support of a great variety of ancillary facilities, the provision of which has stimulated the establishment of new industries.

Fishing vessels and gear are the basic requisites for fish production. The many innovations and improvements in fishing equipment and

methods made in recent years have had far-reaching and varied results on the development of fishing industries. In a number of developing countries, craft and other equipment, and fishing methods which have proved successful in more advanced fisheries, have been introduced and adapted with success to local conditions.

Shore installations required for the operation of fishing fleets include, apart from fishing boat yards and equipment manufacturing and sales establishments, landing facilities, vessel repair shops, fueling stations, ship stores, etc. Ice plants are essential for chilling and cold storage of catches at sea and in conjunction with shore handling, processing, transport and warehousing facilities.

Transport and warehousing facilities as such must often be especially adapted to meet the requirements for fishery products because of exceptional perishability and strong odors which make it difficult to handle them together with other foodstuffs.

4. FACTORS INFLUENCING THE FUTURE SUPPLY OF FISHERY RESOURCES AND PRODUCTS

Fishery resources development

The supply of fish and shellfish for utilization by man can be expanded through discovery of new resources, exploitation of known but heretofore unfished resources, introduction of improved fishing equipment and methods, increased emphasis on cultivation, and better handling of catches to reduce losses through spoilage. The institution of appropriate management practices helps to bring up overfished stocks to higher levels and forestalls declines in stock through overfishing, and thus is of crucial importance in all resources development programs.

Untouched and underexploited resources

Under the auspices of FAO's Indicative World Plan, work on an inventory of information on the world's fisheries resources has recently been initiated. The assembly of data extends to resources which are at present unexploited or only lightly exploited. For some areas a substantial amount of detail is available, whereas for others information is still rather sketchy. On the traditional fishing grounds of the North Atlantic and in parts of the North Pacific, which are generally considered as heavily exploited, in particular as far as most demersal (bottom-dwelling) species are concerned, some pelagic resources (species living freely in the sea) are still underexploited (e.g., capelin, ammodytes, saury). In other oceans, intensive exploitation has generally been limited to species which either occur in very large concentrations (e.g., anchoveta in Peru and Chile, pilchard off the west coast of South Africa), or which have a high unit value (tuna in the open

ocean, shrimp along many coasts), and to local and easily accessible stocks. Important resources which are still underexploited include the demersal hake off the west coasts of North and South America and in the Southwest Atlantic, and pelagic fish (such as sardinella, anchovy, herring, mackerel, hilsa or saury) as well as squid, which are found in many sea areas.

With the rapid increase in fishing in recent years, more and more stocks of both demersal and pelagic species have come under such heavy fishing pressure that yield increases of a more permanent nature cannot be expected. Among the stocks that can be fished economically with techniques used at present, an increasing and substantial proportion — and possibly already, or within a few years, the majority — may be considered "fully" exploited.

Opinions vary widely about the fishing potential of the open ocean, i.e., the area beyond the continental shelf. It is known that the open ocean has vast quantities of fish, but much of the resources consists of small and widely dispersed fish which may not be easy to harvest economically.

Not to be neglected in an evaluation of the development potential of fishery resources are the opportunities for expanding inland water fisheries. Exploitation of the fishery resources of some of the large African lakes has barely started. In addition, the large man-made lakes which have been created in Africa to provide power, water for irrigation, etc., can be expected to become valuable sources of fish protein supplies for areas with serious nutritional problems.

Resources management

Measures to rationalize the utilization of exploited fishery resources are an important part of any fisheries development program.

Less than 20 years ago only the stocks of a few high-priced species, mainly in the North Atlantic and North Pacific, were considered "overfished" by a group of experts. Of some 30 stocks, the group believed to be underfished at the time, about half are now thought to require protection through the institution of proper management measures. In the past, the fishing industry was accustomed to move to other stocks, usually stocks at a greater distance from shore, as the decline in yield became apparent. This will become progressively more

difficult in the future. Although substantial new resources have been discovered in recent years, e.g., in the Arabian Sea and off the west coasts of the Americas, they are, for the most part, located at some distance from the major centers of fishery development. Also, they are often species not very highly prized in the market. For these reasons the new resources are not a fully adequate replacement for the "overfished" stocks. If the present trend of acceleration of exploratory fishing and expansion of long-distance operations is projected into the future, in another 20 years there will be few unexploited stocks of substantial size accessible to then employed gear.

The problem of overfishing arises in fisheries where sole ownership rights do not exist, e.g., in open sea fisheries. In the absence of such rights, the individual fisherman has neither the power nor incentive to ensure that considerations of sound management are observed in fishing operations. His aim is to catch as much as he can as fast as possible since, if he fails to do this, someone else will catch the fish. Thus, effective management depends on the participation of all, or at least of the great majority, of those exploiting a given stock of fish.

Because of the difficulty of achieving proper management of major resources, especially in international waters, there are more examples of stocks declining in the absence of proper management than of stocks and catches building up afterward. The objective of rational management, therefore, is to institute regulatory measures before the overfishing stage is reached rather than to use regulation exclusively, as is sometimes mistakenly assumed, to salvage a fishery that has "gone into the red." Successful management hinges, in the first place, on agreement among those interested in the crop, on benefits obtainable from regulation, and on the principles according to which they are to be distributed when attained. The larger the number, and the more divergent the interests of those with a stake in the resources and their utilization, as well as the more complex the relations of the species making up the fishery to be regulated, the more difficult it becomes to devise acceptable measures. No single objective, maximization of catches in the short run or in the long run to meet existing or anticipated future nutritional requirements, improvement of earnings, etc., is likely to satisfy all the aspirations of producers, processors and consumers of different countries with various economic and social

systems, countries which differ in the degree of reliance they place on deriving food supplies and income from fisheries.

The need for compromise has been clearly demonstrated by the evidence of losses sustained through failure to provide timely management controls. Organizational arrangements, therefore, have been made, both on a national basis, where the fishery is under the exclusive jurisdiction of one country, and on an international basis, where more than one country is interested, to regulate the exploitation of specific stocks of commercial value or of geographically defined fishing areas. Investigations, furthermore, have been initiated to ascertain the effects of exploitation in the absence of controls, as well as under various forms of regulation, to help in the selection of the management regime best suited for the achievement of agreed management objectives.

These investigations, which cover biological, technological and economic aspects, are aimed at providing a rational framework for international agreements on resources management. Future supplies of fish protein, as well as harmonious relations between nations exploiting high seas fishery resources, will surely depend to a marked degree on such agreements being reached with some urgency.

Fish and shellfish cultivation

The fisheries management concept comprises " positive " measures in addition to the " restrictive " measures discussed in the preceding section.

As in agriculture, there are opportunities for increasing aquatic crops through cultivation practices.

Fish farming, notwithstanding its limitations in scale, has a number of advantages. Subject to some qualifications, it can be planned both with respect to location of operations and quantity of supplies. Furthermore, single ownership control and exploitation tend to prevent the waste characteristic of common property resource exploitation.

Fish cultivation is practiced in inland rivers and lakes, coastal swamps and lagoons, dams, reservoirs, paddy fields, village and family ponds, and helps to provide additional fish protein food for local needs in many regions of the world. Freshwater fish farming operations are carried out quite successfully in many countries and on a

large commercial scale in several of them. Marine or estuarine fish and shellfish farming is less common, and conducted on a more extensive basis in only a few countries, mainly in the Far East. The extensive brackish water farming in this region is closely related to heavy reliance on seafoods for protein.

The character and distribution of the resource have a bearing on opportunities for cultivation. Cultivation is difficult, if not impossible, for some species, notably those which live freely in the sea.

This is the case, for instance, for tuna and other pelagic species which travel for thousands of miles. Some species with well-defined migratory patterns lend themselves to a form of cultivation during a part of their life cycle, e.g., fish like salmon, which seasonally return to fresh water. There are possibilities also for the development, by genetic selection and hybridization, of strains of migratory species that can be raised in confined waters.

Mollusks are the most easily cultivated of all marine animals, because many species either live fixed to the sea bottom or are capable of only very limited movements.

Because of the value of the crop, opportunities for commercial shrimp culture are being investigated to an increasing extent.

Technological progress in the fishing sector

Innovations and improvements in fishing equipment and methods in the last few decades have made it technically feasible to exploit resources which could not be fished at the previously existing stage of technology. This has led to an increase in catches, and at times to a lowering of costs of production and cheaper raw material prices.

Simultaneously, technological progress has accelerated the "internationalization" of fisheries and thus increased the urgency of the adoption of management measures. These measures must, in many instances, take the form of a limitation of the number of production units to prevent the loss of the economic rent from fishing.

The advances in fishing technology can be briefly summarized as follows:

Fishing boats

Improvements in boat design and construction have resulted in more versatile and efficient fishing craft.

The science of naval architecture has made considerable progress. With the more general application of scientific principles to fishing boat design, it has become easier to expand fishing operations, to reduce losses of fish and, because of the extended radius of action of improved craft, to increase productivity. The lower fuel requirements of the improved boats have made possible increases in fishing without adding to the cost.

Large stern trawlers have been developed which are capable of freezing and processing at sea. The success of these vessels has focused attention on the possibility of developing small, highly automated, vessels for less distant fishing grounds.

In general, the tendency has been to build faster vessels. Engines have been made lighter but more powerful. In developing countries, the installation of small inboard diesel engines in light fishing craft has become more widespread, as has the use of outboard engines for local craft unsuitable for inboard mechanization.

Considerable progress has been made in the improvement of construction materials for small boats. Improved welding techniques have permitted more widespread use of steel and aluminum. Plastic reinforced with glass fiber, which has good resistance to deterioration in tropical waters, has also been introduced on a limited scale, although it is still costly. Greater use is being made of plywood adapted to marine purposes.

Fishing gear and deck equipment

The development of larger fishing craft equipped with high-powered engines has created a demand for improved fishing gear. The designing of such gear has proved more difficult than expected. Considerable progress has been made, however, also in this field, as a result of the adoption of a more scientific approach to gear development. To cite only a few examples:

Midwater trawling has made headway, among other reasons, because of improvements in net and gear design.

Gillnetting has greatly increased in productivity because of the much greater catching power and durability of the synthetic materials used in the manufacture of the gear.

The development of hydraulic deck machinery, particularly in purse seining, has progressed rapidly. Perhaps more than anything else, the saving of labor by power handling will make fishing a modern industry, which is essential if it is to be able to continue to recruit manpower.

Fishing techniques

In fishing techniques, the outstanding developments during the past ten years have been: firstly, the general use of echo sounders, and more recently sonar, for the acoustic detection of fish; secondly, the almost complete changeover from natural to synthetic fibers for net materials; thirdly, the more fully mechanized handling of gear, which has not only saved labor but also made it possible to fish with better gear, in greater quantities and in deeper water.

The most spectacular example of progress made in recent years is the greatly improved purse-seining technique. The strong, light-weight synthetic twines permit the use of bigger and stronger nets, which are easily hauled with labor-saving power blocks and other powered (mainly hydraulic) winches.

Tuna longlining has also made rapid advances, largely through the pioneering efforts of Japan. It now extends to virtually all waters where deep-swimming tuna are found in worthwhile quantities. A major factor has been the development of fleet planning operations with radio reporting of catching rates and the charting of the fishing operations. Largely as a result of this, the central recording of information on hydrographic conditions suitable for tuna has been developed and stock resources have become better known. This, in turn, has helped the planning of fleet operations. Mechanization of line hauling and the use of harder wearing rot-proof synthetic materials have also been important.

The rate of development in trawling has been slower than in purse seining, as it started from a more highly developed base. The modernization of trawling has nevertheless been impressive. Fleet operations have put trawling on a global scale. Knowledge of the fishing grounds possessed by the skippers is being assembled on fishing charts.

Electronic fish-locating and navigational aids

Advances in electronics have had important effects on the fishing industry. With the development of the white line recorder, the echo sounder has evolved from a navigational instrument concerned with the safety of the ship into what amounts to the equivalent of the fishermen's eyes. The *Netzsonde* has become an essential aid in guiding the net onto schools of pelagic fish and keeping the vulnerable pelagic trawl clear of the bottom. The development of navigational aids such as the Decca navigator system, with its greatly expanded chain of stations, has made possible precision fishing and has also provided an important tool in the preparation and use of fishing charts.

Fish-attracting techniques

Some of the more significant developments are occurring in the field of attracting fish. The use of light, practiced in a number of traditional, small-scale fisheries, is being brought up to date by the U.S.S.R. in the Caspian Sea.

Looking farther into the future, there appear to be possibilities of attracting fish by the use of electric currents, or by sounds, scents, and perhaps tastes. Experiments with electric currents have indicated that certain species of fish respond by turning to face the direction of the electric current and by swimming toward the anode where, presumably, they can be gathered by suction pumps. However, the area of influence is small and the method requires considerable electric power.

Technological progress in handling, processing and marketing

Important advances have been made on three broad fronts: (*a*) processing at sea; (*b*) the application of known physical and chemical principles to such processes as freezing and smoking to rationalize and improve them; and (*c*) the application of concepts of quality control used in other industries to control the processing and final quality of the product.

Handling and processing at sea

Much effort is being devoted to attempts to extend the limited storage life at sea of unfrozen fish. In some countries, the fish are kept in refrigerated sea water to ensure that storage is at temperatures as low as possible without freezing. The storage life of iced fish has been extended also by using antibiotics in the ice.

Processing at sea is moving in three directions: factory trawlers, freezing trawlers, and mother factory ships attended by catching vessels.

In the typical factory trawlers, the fish is caught by stern trawl, filleted and frozen in blocks, while fish offal is converted into fish meal. Canning factory ships for pelagic species such as herring, sardine and anchovy, have also been developed.

As far as the development of freezing trawlers is concerned, both whole-freezing trawlers which freeze the entire catch, and part-freezing trawlers which preserve part of their catch on ice are encountered.

In the operation of mother ships with catching vessels, one of the major problems relates to prevention of quality deterioration during transfer from catching vessel to mother ship.

Handling on land

The increasing interest in freezing at sea has led to a rising volume of landings in the form of blocks of frozen fillets, and whole or gutted fish for subsequent thawing and processing. This has accentuated the need for developing methods making possible the rapid thawing, without loss of quality, of large amounts of such fish. Today, the only processes considered suitable for large-scale commercial use are air-blast thawing and dielectric thawing, or a combination of both.

Among other important technological developments in the sphere of fish handling are devices which can be added to a consignment of frozen fish to indicate whether or not temperature control is satisfactory, and vacuum packaging in films of low oxygen permeability to hold back the development of oxidative rancidity in products produced from fatty fish.

Smoking

The use of mechanical kilns for fish smoking continues to expand. Better control of the production of the smoke is sought. A number of automatic smoke producers have become available.

Canning

Efforts are under way to exploit species hitherto considered unsuitable for canning. Vacuum precooking is said to make possible the utilization of certain types of raw material (e.g., dogfish), and improves the firmness and appearance of herring type fish packs.

The introduction of epoxyresin lacquers has made the prevention of internal corrosion of cans more effective. The use of aluminum for can manufacture is increasing in countries (such as Norway), where this metal competes economically with tinplate. The aluminum cans are reported to compare favorably with tin cans with regard to storage life.

Solid packs such as those prepared from fish tend to be overprocessed by conventional methods due to slow heat penetration. Dielectric heating offers a means of raising the temperature uniformly throughout the pack, thereby reducing the required processing time and also the risk of overcooking.

Prepackaging

There is an increasing interest in the prepackaging of fresh foods. The fishing industry, too, is paying attention to this form of presentation. Experimental work has indicated that, in addition to a more attractive and hygienic presentation, the storage life of the fish may be considerably extended. The degree to which such an extension is possible, however, depends markedly on the type of packaging material used.

Irradiation sterilization

As with other foods, the initial promise shown by irradiation sterilization in the case of fish has not been fulfilled because of the production in the course of the irradiation process of "off" odors in the product. There may, however, be a future in the pasteurization of fish and fish products by low doses of radiation to extend the keeping life, allied possibly with refrigeration and/or the use of antibiotics.

Freeze-drying

Experimental work with accelerated freeze-drying of foods, including fish and shellfish, continues to make progress and a number of experimental and indeed commercial units are in operation. The

application of this process to the fishing industries of the world may have good results. By reducing the weight to be transported, and by making it possible to dispense with refrigerated transport, it may provide an opportunity to process very fresh fish on or close to the fishing grounds and to distribute the products at a satisfactory profit.

Quality control

Until recently, quality control measures were sadly neglected by the fishery industries of the world. Today such measures are being rapidly introduced in most countries.

One problem is the scarcity of methods for determining quality which give reliable and reproducible results. Where quality is a sensory judgment, sensory methods must obviously be involved in the first instance, preferably correlated with objective physicochemical methods. The necessary sensory methods are now largely available for wet and smoked fish and some have been applied under a variety of commercial conditions. The extent of the correlations between sensory tests and physicochemical methods for the quality of wet fish continues to be explored and new methods are being developed.

Although individual factories and organizations often have their own internal quality control procedures, increasingly national or co-operative schemes are being introduced.

New products

New fishery products are being developed not only to improve resource use but also to cater to special tastes or to open up new markets, e.g., among consumers of low purchasing power in need of fish protein in their diets.

Frozen precooked products

Product development work is paying increasing heed to the demand for convenience in preparation and consumption of the fish-buying public in developed countries. Filleting has made fish more acceptable to those afraid of swallowing fish bones. Products that can be

easily prepared for the table have been developed by precooking and are marketed in increasing volume, especially in the United States and other higher income developed countries. Among the products in this category are breaded frozen fish sticks and portions, and breaded frozen shrimp.

Fish sausages

One product in which world interest has been rapidly increasing is the fish sausage. This has some similarity to the meat sausage and contains fish, starch, pork fat, plus such additives as dye, nitrite, polyphosphates and preservatives. A smoked product is also produced.

In Japan, production of fish sausages increased from 2,000 metric tons in 1954 to 188,000 metric tons in 1965. Canada and the United States are other countries producing fish sausages.

Fish protein concentrates

Although still in the developmental stage, the production of fish protein concentrates offers the possibility of providing, at relatively low cost, a high-protein food or food supplement of considerable nutritive value and long shelf life. An additional advantage of these products is that they can be packed and transported easily. They can also be protected more readily against spoilage and beetle infestation than cured fish. Nondeodorized and nondefatted products suitable for use as condiments can be produced in a simple, satisfactory and inexpensive way. Defatted and deodorized products require more complicated processing methods and should be composed of inexpensive fish species in order to keep the cost of the product low. The development of simplified processes for industrial production is under continuous investigation by technologists and process engineers.

At present, large-scale manufacture of fish protein concentrates for human consumption is handicapped by lack of a regular commercial market, although there is a strong need for such products in many developing areas. On the other hand, market development has lagged, due to lack of a suitable product which can be made regularly available in sufficient quantities for promotion and for introductory programs in commercial markets.

The process of manufacture of the "fish flour" type product consists, in general, of cooking and mincing or shredding the fish, extraction of the fats with a solvent such as alcohol — which effectively deodorizes the product — and drying. The final product is odorless and virtually tasteless, may contain up to 90 percent protein, and can be incorporated in bread, soups and other foods which belong to the average diet.

Changes in industry structure and increased efficiency and economy in distribution

Except in Japan, the larger enterprise is a comparatively recent phenomenon in the fishery industries of developed countries. It has been formed mainly through merger rather than internal financing. It is worth noting in this connection that until sufficient progress had been made in supplying processed products to modern type retail outlets, the risks inherent in fisheries operations had held back investment in the industry.

In many countries, institutional factors such as the survival of the share system of dividing proceeds from fishing among the crew and, related to it, the continuation of the port auction system, are partly responsible for the virtual absence, or relatively slow pace, of vertical integration in fisheries operations. Large seasonal fluctuations in supply also have played a part: bringing processing and storage capacity in line with peak fish landings can create serious economic problems. On the other hand, seasonality of supply provides an incentive to diversification and tends to encourage combination with other food-processing operations.

Forward integration, mostly by processors into wholesaling, and to some extent also into retailing, is more common (often aiming at a larger share of the market through brand promotion) than backward integration into fishing. Where companies are competing for scarce resources, however, the tendency to integrate backward prevails. The competition for resources may have the effect of overcapitalization, with processors investing more in boats and gear than what appears required for technical efficiency.

In the future, backward integration is likely to increase as

a result of the shift to freezer-trawler operations and to processing at sea.

Scarcity of management talent for hire, and inability of the management staff of firms to take on additional burdens, place practical limits on the integration process. Conversely, underutilized management talent has, in some instances, provided an incentive for enlarging the scope of activities of an enterprise.

The advantages of integration in fisheries are those reaped generally by large companies rather than benefits connected with specific technical or managerial economics of combined fisheries operations. They consist in concentration of financial resources for the acquisition of equipment and installations, withstanding temporary losses, and making it possible for the enterprise to spread market risks. The ability to hire better crews and managers of shore installations is one of the specific advantages of the large fishery enterprise.

The development of frozen packaged fish has made it possible to tie in the marketing of fish with that of other food products. Also, refrigerated transport facilities, which can be shared by the meat, dairy, fruits and vegetables and other industries have become available. Thus, some of the stimulus for integration has come from developments outside the fishery industry.

Marketing and distribution facilities

Availability of fish and fishery products is affected by seasonal and geographic patterns of production operations. Preservation helps to even out distribution.

Availability of supplies (and, indirectly, the amount demanded, since familiarity with the product in the market by itself suffices to stimulate consumption) also depends on satisfactory facilities and arrangements for transportation, storage and sale.

The presence of such facilities is related to the stage of development of the overall economy. In low-income countries, where these facilities have not yet been created, fish is often eaten only in areas where it is caught. Improved lines of communication are important to the stimulation of demand. It must be realized, however, that in most areas fisheries needs will not rate a sufficient priority to

justify the construction of major infrastructure facilities for their exclusive use.

The insufficiently developed market organization in low-income countries is frequently a serious impediment to the full satisfaction of demand. In some cases, in both low-income and high-income countries, the fishermen themselves restrict output in order to ensure high prices. And in other cases, the marketing agents discourage an increase of supplies so that they can keep risks down and profit margins high.

5. FACTORS INFLUENCING PRESENT AND FUTURE DEMAND FOR FISH AND FISHERY PRODUCTS

As indicated earlier, at present about seven tenths of the weight of the world fisheries catch is used for human food, the remainder for sundry industrial purposes, including for intermediate products used in pig and poultry feeding and the manufacture of margarine and other food products. The demand for these intermediate products is influenced by conditions in the end-product markets as well as by the users' evaluation, in quality and cost terms, of the fish product component in relation to competitive components.

As human food, fish is considered exceptionally valuable from a nutritional standpoint, primarily because it contains a high percentage of readily digestible animal proteins. The demand for food fish, however, is determined by many other factors in addition to nutritional considerations. As for all food products, it reflects income levels, taste preferences and prices relative to those of substitutes. Population trends have an impact not only on total demand but also on per caput demand because of differences in consumption patterns between regions, sexes, age groups, family units of different size, religion, social traditions, etc.

Because of the large variety of food products manufactured from fishery resources, it is difficult to speak of a demand for fish as such. A meaningful discussion of food fish demand must be in terms of specific products such as canned fish, smoked fish, and so on, or more precisely, canned albacore tuna, nuoc-mam, etc.

Demand for products for human consumption

Factors related to taste preferences and consumer habits

Consumer preferences are formed over a long period of time and reflect local availability and regularity of delivery of supplies, and the form in which the fish are offered for sale. Availability and charac-

ter of supplies in the market, in turn, are influenced by the perishability of fish.

Fish tends to deteriorate immediately after being caught. The speed of deterioration varies for different kinds of fish and different methods of handling but depends primarily upon temperature. This has a significant effect not only on geographic and seasonal availability but also on the form of utilization. Since the consumer tends to depend upon, and to demand, the products with which he is familiar, introduction of improved and less expensive processing or marketing techniques for the products traditionally preferred in the market is likely to lead to an increase in per caput consumption.

Even well-established consumer habits, however, may change over the long run. Shifts in preferences and demand may occur when a new condition of supply availability persists over a long period or when the consumer becomes acquainted with a new product. Since food habits do not change very easily, new products can seldom be introduced without substantial advertising and other promotional efforts.

Taboos and superstitions, encountered regionally or locally, mostly in developing areas, are minor factors in fish consumption patterns. "Old wives' tales" may, in certain cases, account for the rejection of specific commodities. With changes in consumer income and product availability, nevertheless, superstitions and taboos tend to become ineffective.

In terms of the overall demand for food fish products, dietary rules related to religious practices are probably of greater significance than taboos. Thus, the recent removal by the Roman Catholic Church, in some countries, of the restriction on meat consumption on Fridays is reported to have led to a rather drastic decline in consumption in several instances. It is too soon yet to say whether or not this impact on markets is of a temporary nature.

Elasticities of demand

Consumer preference for fish and fishery products is functionally related to income and price levels as well as to preferences for other foods.

In high-income countries, per caput income has comparatively less impact on food consumption levels than in low-income countries. The physical quantity of all food consumed per person, for example,

is relatively fixed in high-income countries. Additional weight and a higher calorie intake are not sought and, in some cases, even avoided by the consumer. Consumption rates respond less rapidly to increases in per caput income than to other factors, such as convenience in home processing, awareness of healthful or unhealthful qualities of food, etc. Thus, while the demand for total quantity of food per caput does not increase, shifts in demand and in the pattern of consumption among the various components of the diet do take place.

Demand studies indicate that, in many developed countries, the quantity of fish consumed relative to that of meat has tended to decline; that is, the income elasticity of demand for fish is lower than that for meat. The substitution of meat for fish, however, is limited by the consumer's demand for variety in his diet. The preference for meat will never lead to an exclusive meat diet but will be tempered by the desire to vary the kinds of food consumed. Also, the tendency to substitute meat for fish will be counteracted as more publicity is given to the nutritional advantages of fish consumption.

The pattern of consumption in the low-income countries of Asia, Africa and Latin America is markedly different. Taste preferences cannot be readily satisfied in most of these areas, and the quantitative consumption of food per person can still increase. Income levels of consumers and price of product are of overriding importance in the determination of consumption. Increasing income levels will lead to a much greater response in fish consumption than in high-income countries, and a substantial shift away from cereals, starchy roots, pulses and nuts to fish and other animal protein can be expected.

Since income changes take place rather slowly in developing countries, in the short run shifts in relative prices of food commodities are of greater significance for consumption patterns than changes in income levels. Shifts in price relationships, in turn, depend — apart from supply factors — upon institutional changes and technological developments that affect the costs of one food item more than that of another. Overcoming transportation and marketing impediments is more likely to bear upon all food equally than any single food item individually, so that, while the total expenditure for food may drop, the price of one food item compared with another may remain about the same. Technological developments in production and processing, however, may significantly affect the costs of a single food industry and, assum-

ing that the lower costs are translated into lower prices to the consumer, may lead to a marked shift in consumption patterns. The development of a low-cost " cold chain " or some new and more economic method of preserving food may concern all sources of animal protein in the same way, or lead to only a slight change in competitive relationships between different food items. The development of a low-cost fish protein concentrate, on the other hand, might create unique advantages for fish, not matched by technological changes in protein concentrates from milk or other sources (or, of course, the reverse may apply: technological development may be faster in other sectors than in fisheries).

Demand for products used for industrial purposes

Most of the fishery products used for industrial purposes are " intermediate products," i.e., they are incorporated into other products because they provide important ingredients of the end products in better quality or at less cost than possible substitutes. Meal and oil, the leading industrial products produced from fishery resources, are to a large extent utilized as components in the manufacture of food and other industrial products and animal feedstuffs. Marine oils, which are end products (e.g., oils used in lubrication), and meals, which are mixed directly into the feed rations by the farmer instead of being sold to feed compounders, as well as sundry other " industrial " fishery products not derived from reduction operations, represent a relatively modest share of the total value of the output of industrial fishery products.

Relationship of the demand for intermediate products to the demand for end products

For the most part, fisheries components represent so small a share of the value of end products that the demand for them depends significantly upon conditions in the end-product markets. Therefore, to forecast the demand, for instance, for fish meal, probable future developments in the markets for poultry meat, eggs and pig products have to be assessed.

Some recognizable patterns in the utilization of intermediate products are related to geography and conditions in end-product markets. In North America, for example, fish meal is primarily used for poultry feeds, while in Europe utilization for pig feeds appears to be equally important, at least in some of the major markets. Production of pig and poultry products is characterized by considerable fluctuations; periods of high prices and low supplies, and of low prices and large supplies, follow each other with regularity. Other things being equal, the demand for fish meal will tend to vary in response to short-term changes in pig and poultry populations, and to associated financial and psychological effects of changing profits on farmers.

Competitive and other factors influencing the demand for intermediate products

Aside from factors primarily related to end-product markets, the demand for intermediate products will be influenced by the following:

(*a*) current and expected future prices relative to current and future prices of competitive components;

(*b*) regularity of supply relative to regularity of supply of competitive components;

(*c*) quality and uniformity of quality of the intermediate product;

(*d*) institutional factors, such as health or quality regulations, which limit the response of demand to price changes or which influence the time required to secure a given response to a particular price change;

(*e*) established practices in utilization (comparable to the consumer preferences and habits which influence the demand for end products).

In his evaluation of the comparative economic value of intermediate fishery and substitute components, the end-product manufacturer will consider relative technical efficiency, in addition to cost and regularity of supply. Thus, up to a certain percentage (say 2 percent), incorporation of fish meal in rations may be sufficiently desirable, because of the meal's contribution of essential nutrients, to induce the feed compounder to pay a premium, beyond a certain maximum "techni-

cally advisable " percentage (say 10 percent); on the other hand, the fish-meal component may actually jeopardize the acceptability of end products, such as poultry meat, because of " fishy " flavors.

Projections of the demand for food fish

In demand projections over the longer term, population is the most important factor. A given increase in population implies, *ceteris paribus*, a commensurate increase in food requirements. The level and pattern of future per caput consumption is largely determined by the rate of growth of income.

The demand for an individual commodity, finally, is influenced by the strength of the potential buyer's desire for acquiring it as against any other commodity which is in his normal expenditure budget. For staple food items, his expenditure decision will to a large extent depend on price relationships with competing products which, in addition to degree of need or strength of desire, reflect also availability of supplies. The demand for luxury type products is influenced too by other than price factors, such as prestige.

From the foregoing it is evident that, when demand is projected on the basis of population and income trends, it will correspond to consumption only as long as future supplies are available at constant prices and consumer preferences not necessarily related to monetary factors remain unchanged.

As far as projections of the demand for fishery products are concerned, changes in resource availability are likely to have a material effect on future prices. Also to be considered are future government policies which, especially in developing countries, are likely to have a substantial influence on production and marketing patterns.

FAO PROJECTIONS FOR 1975 AND 1985

The future demand for food fish, by individual countries and by regional groupings of countries, has been forecast in two recent studies of FAO on agricultural commodities.[1] Since only population and

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[1] FAO. *Agricultural commodities - projections for 1970.* Special supplement to *FAO Commodity Review 1962*, and *Agricultural commodities - projections for 1975 and 1985* (two volumes), prepared by FAO for the Forty-first Session of the Committee on Commodity Problems. Rome, 1966.

income could be considered, no attempt was made to forecast actual consumption. The projections provide an indication of the quantities of fish which consumers would be prepared to buy in the future if prices were in the same relationship to prices of other products as they are today, and if no shift in preferences, not related to price factors, were to take place.

The target years of the more recent of the two FAO studies were 1975 and 1985. For the projections for 1975, a single population growth assumption and two income (measured in terms of gross domestic product [GDP]) growth assumptions, a high and a low one, were used. For the second decade (1975-85), the two income growth assumptions were related to two population growth assumptions, the second population growth assumption being based on the premise that family planning policies might exert an effect on the rate of expansion over the longer term.[2]

Projections of per caput demand for fish were arrived at by determining the percentage change in consumption associated with a given percentage change in the coefficient of income elasticity of demand at a given time; and the function best describing the change in income elasticity with changing levels of income over the projection period. To calculate these data, household consumption and/or expenditure surveys and time series indicating net per caput availability (annual production data adjusted for changes in trade and stocks) were used.

The response of fish consumption to income changes was found to differ substantially from country to country, and between developed and developing countries. Thus, during 1962, the base year for the FAO projections, a 10 percent income change was associated with a change in fish consumption of 2 percent in North America, and of as much as 15 percent in India and Pakistan.

Similarly, significant differences were noted in the change in income elasticity over time. For the large majority of developing countries, as well as for Italy and Turkey, elasticity of demand was estimated to remain constant over the projection period, implying that fish consumption would continue far below the saturation level. For all other

[2] Of the four projections resulting from the combination of the two population and two income assumptions for 1985, only those representing the lowest (low population and low GDP growth rates) and the highest (high population and high GDP growth rates) estimates are given in Table 6 (see page 60).

countries, income elasticity of demand was projected to decline in varying degrees over the projection period, with the following results on fish consumption:

(*a*) an increase, but at a declining rate, in most developed countries, as well as in a few Latin-American countries (Argentina, Brazil, Mexico, Peru and Uruguay), consumption never reaching the saturation level;

(*b*) an increase, with the growth curve flattening out so as to tend toward a saturation level, in Portugal, Spain, Japan and the Republic of Korea.

With the help of the forecasts of population and income (GDP) prepared by the United Nations and the data on income elasticity, indices of per caput and total demand for fish in 1975 and 1985 were projected from data for the base year. These indices were used for estimates of the world demand in 1975 and 1985, in catch weight, for food fish.

Table 5 shows that by 1975 food fish supply requirements of developed countries would be between 19 and 20 million tons, those of centrally planned countries between 14.5 and 16.5 million tons, and those of developing countries (excluding Mainland China) between 13 and 15 million tons. Two thirds of the total supplies of developing countries would be consumed in Asia and the Far East.

The range between low and high estimates of requirements widens considerably as the projection period is extended to 1985 (Table 6). Thus, at high income and population growth rates, the food fish supply needs of developing countries (excluding Mainland China) would be about 25 million tons, one third larger than the estimated 18.5 million ton requirements at low growth rates. The corresponding range for developed countries would extend from 21.5 to 24 million tons, and that for centrally planned countries from 20 to 25.5 million tons.

According to the projections in Tables 5 and 6, the world catch of fish would have to increase, solely to cover additional requirements for food, from the 1965 level of 52 million tons, by 11 to 15 million tons by 1975, and by 24 to 38 million tons by 1985.

TABLE 5. - PROJECTION OF THE WORLD DEMAND FOR FOOD FISH IN 1975

World total and groups of countries	1965 food fish supplies [1]	1975 demand projected from 1965 base	
		At low GDP growth rate	At high GDP growth rate
	Thousand metric tons		
WORLD TOTAL	36 100	47 000	51 200
Zone A (developed countries)	16 000	19 000	19 800
Zone B (centrally planned countries) [2]	10 600	14 700	16 400
Zone C (developing countries)	9 500	13 300	15 000
Latin America	1 500	2 100	2 300
Africa	1 400	1 900	2 200
Near East	300	400	500
Asia and Far East [3]	6 300	8 900	10 000

[1] Estimated availability - production plus imports minus exports. — [2] Including Mainland China. — [3] Excluding Mainland China.

NOTE: Supply data for 1965 calculated from FAO *Yearbook of fishery statistics*. 1975 projections calculated from indices in Table "C" of *Agricultural commodities - projections for 1975 and 1985*, Vol. II.

TABLE 6. - PROJECTION OF THE WORLD DEMAND FOR FOOD FISH IN 1985

World total and groups of countries	1965 food fish supplies [1]	1985 demand projected from 1965 base	
		At low GDP and population growth rates	At high GDP and population growth rates
	Thousand metric tons		
WORLD TOTAL	36 100	60 200	74 300
Zone A (developed countries)	16 000	21 600	23 900
Zone B (centrally planned countries) [2]	10 600	20 000	25 400
Zone C (developing countries)	9 500	18 600	25 000
Latin America	1 500	2 900	3 500
Africa	1 400	2 700	3 700
Near East	300	700	800
Asia and Far East [3]	6 300	12 300	17 000

[1] Estimated availability (production plus imports minus exports). — [2] Including Mainland China. — [3] Excluding Mainland China.

NOTE: Supply data for 1965 calculated from FAO *Yearbook of fishery statistics*. 1985 projections calculated from indices in Table "C" of *Agricultural commodities - projections for 1975 and 1985*, Vol. II.

Consumption targets determined on the basis of nutritional requirements

Protein supplies to cover nutritional needs can be estimated on the basis of data on the composition of population (age, sex and other characteristics) and average body weight figures for the individual population groups. Nutritional targets established in this manner can provide a guideline only of a very long-term nature, because a large part of the population of the world cannot afford to buy the quantity of protein required to maintain health and working efficiency.

Total protein, and total animal protein, supply targets were calculated from data obtained in the course of FAO's *Third world food survey*. Short-term targets (aiming at the elimination of undernutrition and a reasonable improvement in the nutritional quality of diets) were fixed for the year 1975. Long-term targets established at the same time referred to the year 2000 and were intended to give an idea of the scope for improvement in diets as the problems of poverty and scarcity became less acute.

As can be seen from Table 7, for the developing countries as a whole, an increase of 61 percent in total protein supplies over the 1960 level was thought to be needed to bring consumption up to the 1975 target, and an increase of 207 percent to bring it up to the long-term target. For animal protein supplies, the corresponding figures were 115 and 438 percent.

The need for boosting animal protein consumption is most urgent in the Far East, where a more than sixfold increase in consumption was considered necessary to meet the long-term objective of providing adequate diets for a rapidly increasing population.

Table 8 shows short- and long-term total protein, animal protein and fish protein targets for the Far East region. In the short run, fish (because of the relative cost advantage of some forms of cured fish over other animal protein food sources) was considered of increasing importance in the provision of both total and animal protein supplies. In the longer run, it still was to make up a growing part of total protein supplies, but consumption of other animal protein, such as red meat, poultry and milk and milk products, was expected to expand at a relatively faster rate.

TABLE 7. – INDICES OF PROTEIN SUPPLIES UNDER SHORT-TERM AND LONG-TERM TARGETS, BY REGIONS (RETAIL LEVEL)

	Total protein		Animal protein	
	Short-term target	Long-term target	Short-term target	Long-term target
	1975 population [1]	2000 population [1]	1975 population [1]	2000 population [1]
	Indices, available supplies for 1960 population = 100			
Latin America [2]	170	[3]...	195	[3]...
Far East [4]	164	314	226	621
Near East	144	264	208	463
Africa	146	264	213	498
All above regions	161	307	215	538
WORLD [4]	145	250	156	304

SOURCE: FAO. *The state of food and agriculture 1964.*

[1] United Nations "medium-assumption" projections. — [2] Excluding River Plate countries. — [3] No long-term target has been set for this region. — [4] Including Mainland China.

TABLE 8. – PROJECTED TOTAL AND ANIMAL PROTEIN SUPPLY AND FISH SUPPLY NEEDS IN THE FAR EAST [1] UNDER SHORT-TERM AND LONG-TERM NUTRITIONAL TARGETS

	1960 (base)		1975		2000	
	Grams per caput per day					
Total protein	55.9		67.5		73.9	
Animal protein	7.8		12.5		19.6	
Fish	2.2		3.6		5.2	
	Percentage					
Fish as percentage of total protein	3.9		5.3		7.0	
Fish as percentage of animal protein	28.2		28.8		26.5	
	Index	Quantity	Index	Quantity	Index	Quantity
		Million tons		*Million tons*		*Million tons*
Total fish supply needs (catch equivalent)	100	[2] 14	233	33	588	82

SOURCES: FAO. *The state of food and agriculture 1964; Yearbook of fishery statistics*, Vol. 20.

[1] Including Mainland China. — [2] Estimated availability in 1960 (including Mainland China).

In the short run, it was calculated, fish protein supplies would have to be 2⅓ times, and in the long run almost 6 times as large as in 1960. This means that, provided the species composition of consumption remained approximately the same over the projection period, the food fish supply in the region would have to be of the order of over 33 million tons in 1975 and of over 82 million tons in 2000 — figures which may be compared with 1960 supplies of approximately 14 million tons.

Future markets for fishery products

Future consumption cannot be forecast by solely considering what a larger population is going to be able to buy nor by calculating what it will take to keep the human machine in good working condition. Government action influences both the production and the consumption of goods in varying degrees, depending on the organization and structure of the economies of individual countries. Intervention is most far-reaching in centrally planned countries and in those developing countries where private initiative has not yet sufficiently progressed to play a significant part in investment decisions, and where a large part of the population is unable to provide for its own needs.

While there is little doubt that in most countries future fish consumption is going to be decisively affected by government policy, in the industrialized countries of the west future demand is going to be affected also very strongly by consumer preferences (reflected in expenditure patterns) as well as by developments in markets for agricultural products.

Supply conditions will have a considerable impact on consumption. Costs of production, and prices to the consumer, of many species are likely to rise considerably if present trends in fish production continue, and if future assessments of underexploited resources do not permit a fairly drastic upward revision of production potential.

In developed countries

In developed countries, one may generalize, demand is strongest for a restricted number of high unit-value food fish products. Many of the species from which these products are produced are already in relatively short supply and one must assume that, in the future, supplies are going to be available only at rising prices. Eventually,

prices might reach a level where consumer resistance could seriously jeopardize markets. At this stage producers, too, who in some instances have already been hurt by rising production (wages and supplies) costs which they were reluctant to pass on to buyers, would feel the impact of scarce supplies. Some relief in the pressure on "luxury type" species and products may come as the result of new forms of utilization which may permit substitution of less preferred species. Yet substitution would come only slowly because of the tenacity with which consumers hold on to established food preferences.

The income elasticity of the demand for food fishery products in the "staples" category in developed countries is far lower than that for luxury type products. In some of the higher income countries, a few of these items are even classed among "inferior" products, the consumption of which tends to decline with rising incomes. While these products still account for a considerable share of the total market for fishery products, the industry will find it difficult to shift rising costs to the consumers in the future, and will have to struggle to maintain sales volume, through effective merchandizing, development of new products, adding of convenience features, etc.

In centrally planned countries

In centrally planned countries, fisheries policies are likely to continue to aim, at least as long as fish protein is cheaper than land-produced animal protein, at increased production of staple type frozen and cured fish. A growing proportion of supplies will be processed at sea from species taken in the open ocean.

The fishing effort of the centrally planned countries may remain high, even after the currently prevailing relative cost advantage of fish versus other animal protein shows signs of disappearing and reduction of stocks will make operations increasingly less economic, because of reluctance to write off a huge fleet investment.

In developing countries

As is true also of other commodities, the developing countries, while most urgently in need of additional fish protein supplies, are at the same time the least able to cover their requirements. For the most part they lack the means — the financial and skill resources — for large-scale production and distribution of fish and fishery products. At the

same time, they cannot afford to use scarce foreign exchange for importing even the cheaper varieties of products in the quantities needed to satisfy the animal protein requirements of their rapidly expanding populations. Because fish protein, when produced and marketed in a form requiring only simple processing and distribution facilities, costs the consumer less than any other animal protein product, with the exception perhaps of dried skim milk, the governments of developing countries tend to give high priority to the promotion of fishery industries producing inexpensive products for the domestic market. This policy is justified also by the nature of the demand for fish: the studies of income elasticity trends have shown, as mentioned earlier, that over the next two decades, in all but a few developing countries, consumption is going to remain far below saturation level.

On their own, developing countries will not be able to solve the problem of making more fish available in domestic markets. Developed and centrally planned countries, and international aid agencies, all will have to do their share in giving the developing countries an opportunity for increased participation in fisheries, lending them capital and skills for the launching of larger scale operations, and in helping them to develop markets and to educate consumers, etc. Moreover, before the developing countries can meet their requirements from their own production, humanitarian reasons may oblige the rest of the world to provide food aid in the form of fishery products or to make available imports at special bargain prices in order to prevent famines and mitigate nutritional crises.

The developing countries, one must stress, need vast quantities of inexpensive fish supplies, mostly cured fish products produced from the cheaper varieties used for food. These needs will only be met if their governments and all other members of the world community make some sacrifices, since for some time to come private enterprise will not find it attractive to supply products to consumers of low average purchasing power.

The relationship between future markets of food and nonfood fishery products

To complete the discussion of future demand, a few observations are in order on expected trends in the utilization of industrial fish. Food fish and fish-reduction industries are closely linked to each other.

Fish meal and fish oil, it may be assumed, are going to be available in plentiful supply as long as:

(*a*) fisheries in developed countries can continue to supply to reduction plants raw material for which no other market has been developed, at a price which enables the industry to produce products which are competitive with alternative intermediate products; and

(*b*) developing countries find it more advantageous to export meal than to utilize the raw material for the production and distribution in local markets of products for human consumption.

Some experts believe that the share of catches utilized for fish meal processing is going to increase further in the future. According to these estimates, in 1980 as much as 25 to 30 million tons of a probable world catch of 75 million tons may be used for reduction, and by the year 2000, 35 to 45 percent of a world catch of 100 million tons.

These estimates might be considerably off the mark if development of synthetic and other substitutes were eventually to put a brake on the expansion of fish meal markets, and if government policies in developing countries (as well as food aid programs of developed countries) were to aim at an increase in direct consumption in areas where the need for additional animal proteins is most urgent. In the shorter run, the species used as industrial raw material may be available in sufficient supply to meet the requirements of both fish meal industries as well as of markets for low-priced fish products in developing countries. Even at the present stage, however, government and bilateral and international aid policies are likely to seek to expand production and utilization of fish for human consumption in developing countries, because of the large unsatisfied demand for animal protein foods of these countries, and because of the relative cost advantage of fish over other animal protein.

In the long run, not enough "cheap" fish may be available to satisfy simultaneously the demand for animal protein in developing countries and the demand for fish meal in developed and centrally planned countries, and some system of priorities may have to be established. Thus, if catches, by the year 2000, are of the order of 100 million tons, it will not be possible to deliver some 40 million tons to

reduction plants and, at the same time, meet fish protein requirements for the improvement of diets in the Far East alone (estimated to exceed 82 million tons in 2000 - see Table 8), without even considering the contribution of fish to food supplies in the rest of the world. Given the limitations on the resources side, some priority system of supplying markets would have to be worked out. In the very long run, scarcity of high-value animal protein foods may, even in developed countries, necessitate an " upgrading " of reduction raw material and diversion to the production of products for human consumption if attempts to expand food supplies through marine fish farming are not notably successful.

6. INCREASING SUPPLY AVAILABILITY AND PROMOTING CONSUMPTION

In developed countries

Most developed countries have attempted to maintain the living standards of fishermen and the ability of their fishing industries to compete effectively by providing price supports, subsidies, tariff protection and sundry fiscal advantages. Assistance in development efforts has usually been based on programs for market expansion, increased productivity, exploration of fishing grounds and research on new gear and fishing methods. Considerable efforts have been made to increase the demand for fish through advertising and marketing campaigns.

In many cases, research on, and management of, fishery resources is the exclusive concern of governmental, regional and international bodies. This is both because of the common property character of marine fisheries and because of the large expenditures connected with oceanographic and exploratory fishing investigations.

Surveys of ocean areas have been organized under regional and international auspices. Special bodies with regulatory authority have been set up to propose and enforce management regulations in fisheries for individual species or on specific fishing grounds.

Government programs for increasing productivity and reducing costs have generally been limited to the fishing sector, although sometimes they have also included the processing and marketing sectors of the industry. Much emphasis has been given to the establishment of quality standards and to quality improvement. The most common aim is the rationalization and modernization of fishing fleets. The western European countries and Japan have continued to provide government grants and loans for the purchase of new vessels and equipment and have subsidized technological research.

Increased attention is being given to the development of new processing methods and products. In the United States, a law recently

came into effect authorizing the development "through the use of experiment and demonstration plants, or practicable and economic means for the production by the commercial fishing industry of fish protein concentrate." Under this law, construction of one pilot plant and the leasing of an additional plant were authorized upon approval of a fish protein concentrate product for human consumption.

In other developed countries, too, government research agencies are assisting the industry in exploiting food technology advances which are opening up new uses for fish as human food. In Canada, for instance, fish "frankfurters" and similar products, fish or fish-and-potato flakes, and other grocery lines are being developed, especially with a view to utilizing species less favored in the fresh form.

The United Nations and its specialized agencies, as well as organizations concerned with regional planning and/or economic integration, e.g., the Organization for Economic Co-operation and Development (OECD) and the European Economic Community (EEC), are playing an increasing role in co-ordinating fisheries research, obtaining agreement on conservation policies, establishing quality standards, promoting the exchange of experience and information, and in other activities which help governments and industrial enterprises of developed countries to plan and implement fisheries programs and projects.

In developing countries

To make available to the developing regions vastly increased supplies of fish protein, programs in a large variety of fields have been initiated in recent years. These programs which, *inter alia*, encompass dissemination of the findings of modern science and technology, creation of a favorable climate for investment, removal of institutional barriers to increased production, expansion of education and training to improve the performance of operatives, promotion of fish protein consumption and the establishment or improvement of facilities for production, processing, preservation, packaging, handling, storage and transportation, are growing both in number and scope and are implemented with the help of bilateral and international assistance agencies.

Where opportunities for selling high unit-value products in foreign

markets exist, new industrial complexes have come into being. At the same time, projects aiming at the improvement of traditional operations serving the domestic market are promoted. Nor are subsistence operations neglected, as farmers are being shown ways of supplementing their diets with fish raised in farm fish ponds.

In many developing countries, supplies of cheaply preserved and processed products, mostly dried salted and unsalted fish, can be expanded by improved processing and by the provision of adequate storage and transport facilities. Efforts along this line can go a long way toward reducing the large losses in distribution attributable to spoilage and insect infestation.

Consumer education, too, is a vital element in any program of market expansion. Information on the nutritional value of fish and on preparing fish for the table is provided in schools and in the community, with special attention being given to women's groups.

Various educational methods are used, including lectures, displays and exhibits, group discussions and study circles. Demonstrations of the preparation, storage and preservation of fish in market places and shops have proved particularly useful, and mobile vans, suitably equipped for demonstrations in urban and rural areas, have been introduced in several countries. Pamphlets, bulletins, filmstrips and films have been widely used, and pictorial material has been found effective in reaching illiterate consumers.

In some instances, fish-eating has been popularized through institutional feeding programs. Fish was given a prominent place in the food rations which, until a few years ago, were part of the remuneration of workers in the "copperbelt" of Central Africa. Although the system has been abolished, the food habits formed at the time have survived, and fish has remained an important component of the diet of the population in the region.

Consumer education is of special importance where attempts are being made to introduce new products into the market.

Success in fisheries development depends, to a large extent, on the availability of adequate financial resources. In the developed countries, private enterprise can be relied upon to provide the bulk of the financing for fisheries projects. In developing countries, most of the burden must be assumed by the governments. Rival claims of other branches of the economy often reduce the funds available to the fishery

industry, and there are many instances in which implementation of programs has been seriously hindered by the shortage of capital and foreign exchange (for the acquisition of facilities not available locally).

To make up the shortages of capital and skills, international, regional and bilateral agencies have had to co-operate in the efforts of developing countries to develop their fisheries. Assistance has been provided in the form of investment capital, expert advice in the planning and implementation of projects, establishment of training and research facilities, organization of demonstration and pilot stations, fellowship tours, etc. In the international sphere, FAO has been responsible for the technical aspects of fisheries development work, the financing being provided, to a large extent, by the United Nations Development Program (UNDP) and its predecessor agencies. Technical assistance experts have been assigned, and research and training institutes established, in virtually all developing countries with significant fisheries development potential. Advice and assistance have been given in resources research, experimental fishing, introduction of new, and improvement of existing, boat and gear types, the training of fishermen, and processing and distribution operations.

A comparatively recent development in the field of international co-operation is the assistance given under the FAO/IBRD and FAO/Industry Co-operative programs. The former aims at the identification of projects suitable for international financing in the field of fishing harbor construction, fleet expansion, and other aspects of industrialization of fisheries in developing countries. The FAO/Industry Co-operative program seeks to promote private industry participation in development activities.

FAO's assistance in development work has not been limited to field activities. The Organization's headquarters program has included projects seeking to meet the needs for information and advice for the planning of fishery development and the institution of improvements in all sectors of the industry. Meetings on technical subjects have been organized, handbooks and manuals prepared, bibliographic and other reference material assembled and distributed, codes of practice and international standards drawn up, etc., to promote the exchange of experience and knowledge and thus to help in expanding fisheries production and trade.

7. SUMMARY AND CONCLUSIONS

Resources

The fishing pressure on many of the high unit-value resources of fish, shellfish and aquatic mammals is considered high, in some cases so high that prompt adoption of appropriate measures for the control of fishing effort must be urged to protect the stocks. Continued localized depletion seems likely, since demand and effort are focused primarily on a few species fished within relatively small areas of the ocean.

The hunting of marine resources in international waters more and more requires technology and large-scale organization. Increased industrialization and internationalization of fishing have reduced stocks and are the cause of decreased returns per unit of effort and of conflicts between countries participating in high seas fisheries.

In the exploitation of common property fishery resources threatened by "overfishing," regulation of a type leading to a reduction in the number of fishing units seems desirable to conserve valuable resources, forestall economic difficulties and reduce the likelihood of political clashes.

At the present state of knowledge, unexplored or underexploited resources are, in the main, low unit-value pelagic fish species and mollusks. Greater difficulty of capture as well as reluctance on the part of consumers to accept them as food tend to place these resources in the "marginal" category.

The use of new techniques to modify the resources of the seas holds out some promise for increasing the fish crop. Any sizable addition to food supplies is not likely to occur, however, without the adoption of unfamiliar and expensive production methods. The latter include

increasing fish populations, and the nutrient supplies they need, by means of sea-farming techniques (seeding of plankton, creation of artificial upwellings, pollution control to prevent adverse effects on stocks, etc.); improving the quality of the stocks through genetic manipulation, the destruction of useless predators, and so forth; and the creation of new resources by transplantation and other means. It is even possible to envisage such developments as the use of underwater craft for the pursuit and capture of fish and experiments on fertilizing surface waters.

As of now, only a start has been made along the above lines, chiefly with the transplantation of individual species. As far as some of the more ambitious projects are concerned, the costs of implementation appear prohibitive. The time may come, nevertheless, when technological progress will make practicable the application of these methods in the interest of a large and urgently needed expansion of the world's protein supplies.

Production

With increased industrialization of fishing operations, the concentration of the world catch in the hands of a few countries has become more pronounced. Parallel patterns of concentration of markets, and of capital required for the introduction of modern technology, may contribute to a continuation of this trend, unless opportunities are created for developing countries to expand their fisheries operations. With few exceptions, such as Peru, these countries have not had a large share in the substantial increase in world fish production since the end of the second world war. For the most part, they have lacked the financial and skill resources to participate in the technically more advanced high seas fishery operations. They also have found it difficult to increase distribution in domestic markets, both because of technological factors and low consumer purchasing power. However, for many developing countries, the prospects for expanding fishing operations, especially in offshore waters, are excellent and, given the necessary assistance, the developing regions as a whole are likely to have a more important part in world fisheries production and distribution in the future.

Systematic planning, the possibility of organizing fleets of catching, factory and supporting vessels, the absence of interest charges on investment capital, the lack of pressure from "competitive" protein products in the market, have created, and may continue to create, favorable conditions for the expansion of the fisheries operations of countries with centrally planned economies.

Fishery enterprises in developed countries with market economies lack some of the advantages enjoyed by enterprises in centrally planned economies. Where the industry is of special importance in the general economy, nonetheless, the government is likely to provide the necessary support for economic survival.

Utilization and processing

Different species vary as to suitability for different types of processing, on the basis of availability, cheapness and regularity of supplies as well as physical size and chemical composition (e.g., water and fat content). Preservation, handling and distribution difficulties impose severe limitations on the use of "fresh" fish in tropical climates. Canning for domestic use is likely to occupy only a relatively minor place in the industries of most developing countries until lower unit-value species like sardinella and related fish and the cheaper varieties of tuna-like fish can be economically exploited and marketed. Since cured fish appears to offer the best immediate possibility of increasing supplies, especially in areas at a greater distance from the coast or from the shores of lakes and rivers, development efforts are likely to put continuing, and in some cases even increasing, emphasis on the improvement of traditional methods of fish preservation. Before markets have been developed for inexpensive fish protein concentrates and inland distribution of frozen fish has substantially expanded, the urgent needs for additional animal protein of developing countries are likely to be met most economically from increased supplies of cured products produced in the traditional way.

Considerable improvements are possible in the application of chilling to preserve freshness during distribution, and the growth of the fisheries of developing countries is likely to lead to a great increase in the demand for ice. Although new methods of preservation, such

as radiation pasteurization, or superdehydration, combining near-perfect reconstitutability with good storage properties, may one day alter the situation to some degree, the extended application of existing methods of freezing and canning for long-term preservation are likely to be more important in the more immediate future, from the standpoint of the requirements of developing countries.

A large share of the increase in world catches in recent years has been accounted for by fisheries for raw material for industrial products (largely animal feeds). While use for feedstuffs makes a smaller nutritional contribution than fish used directly for human consumption, it indirectly adds to human food supplies. Much fish goes into reduction that, under present conditions, would not find other markets.

The principal product of the reduction industry, fish meal, is today used primarily in the farming operations of industrialized countries. A large part of supplies has been imported in recent years from developing countries where the animal protein content of diets is still quite inadequate.

Notwithstanding their great nutritional needs, these developing countries may have to give even further emphasis to fishing for raw material for reduction operations in the more immediate future, in order to earn, through export, the foreign exchange necessary for the expansion of their economies, including fishery industries serving the domestic market for food fish.

The character of production has changed with increasing industrialization, and technology has become more complicated. Processing at sea has grown considerably with the extension of the radius of fishing operations, and thanks also to technological developments and to the organization of integrated fleet operations. So far, however, only very large enterprises have been able to cope with the financial and crewing problems encountered in running vertically integrated high-seas fisheries operations.

Some freezing, canning and fish meal production operations require heavy commitments in servicing capital. These commitments can only be entered into economically where the catch is sufficiently large, cheap and regular, and where it consists of a few main species or groups for which there is a large enough home or foreign market in which to recoup the overheads.

Consumption and trade

In developed countries, particularly in North America and western Europe, demand is concentrated on certain species of fish rather than on fish as a whole. The general trend is toward luxury type, more elaborately processed, products with "convenience" characteristics (e.g., "ready-to-serve" products). Lower unit-value products often are in strong competition with other animal protein products such as poultry, red meat and egg products. Per caput consumption varies substantially with geographic location (e.g., between coastal and inland markets), income group, and other population characteristics, such as the composition and size of family units, age, religion, employment of the homemaker, etc.

In centrally planned countries, fish protein has been considered cheaper to produce than land-produced animal protein. Fisheries policies are likely to continue to aim, as they have in recent years, at increased production of staple type frozen and cured fish.

While in the world as a whole fish makes only a relatively modest contribution to diets, in some developing countries, notably in the Far East, it is the most important source of animal protein and has a significant place in the overall diet. Where readily available, fish is usually the cheapest form of animal protein in developing countries and has, therefore, the greatest short-term potential for improving the quality of diets.

About one third of the world catch is traded in international commerce. For the catch for food purposes, the proportion exported is about one fifth, for fish meal and oil roughly two thirds. Other commodities produced to an important extent for foreign rather than domestic markets are frozen fish fillets, shellfish products, salted cod and related species, and canned products manufactured from salmon, tuna, herring and related species. Exports account for an increasing share of production of all except the two last-mentioned commodity classes.

World trade is influenced by the circumstance that the effective demand for fish and fishery products comes largely from a comparatively small number of high-income countries. Although many countries export or import fish, the bulk of the trade is between relatively few of them.

The volume of world trade in fish and fishery products has shown a great expansion in recent years, by far the largest factor in the growth being the shipments of fish meal originating in Peru. As far as fish for food is concerned, most of the major exporters and importers are developed countries, many of them with advanced fishing industries.

Many developing countries have valuable resources of shellfish which, though of high protein value, are generally more important as earners of foreign currency, in view of the strong demand for these products in industrialized countries, than as food for the local population. Development plans are taking account of this, in recognition of the fact that a relatively modest investment can bring a good return on capital as well as an addition to supplies of foreign exchange.

High priority in development efforts is given also to the production of products for direct human consumption from what are at present considered "marginal" resources used for reduction purposes. In this connection, it is necessary to point out that, for some time to come, private enterprise will not find it attractive to supply inexpensive products to the malnourished poor of the developing regions. If fish is to fulfill its potential role in the fight against hunger, public policy will have to be oriented toward giving developing countries an opportunity to participate in increasing measure in the harvesting and domestic utilization of fishery resources. The products required for this market may very well be, in the more immediate future, primarily cured products produced by simple means from the cheaper varieties of fish.

On their own, developing countries will not be able to solve the problems. Developed and centrally planned countries and international aid agencies will have to lend capital and skills for the launching of large-scale fishing and fish-processing operations and help in developing markets, educating consumers, etc. Moreover, before many developing countries will be able to meet fish protein requirements from their own production, the rest of the world may have to provide food aid in the form of fishery products (or make available supplies at concessional prices) to prevent famines or mitigate nutritional crises.

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